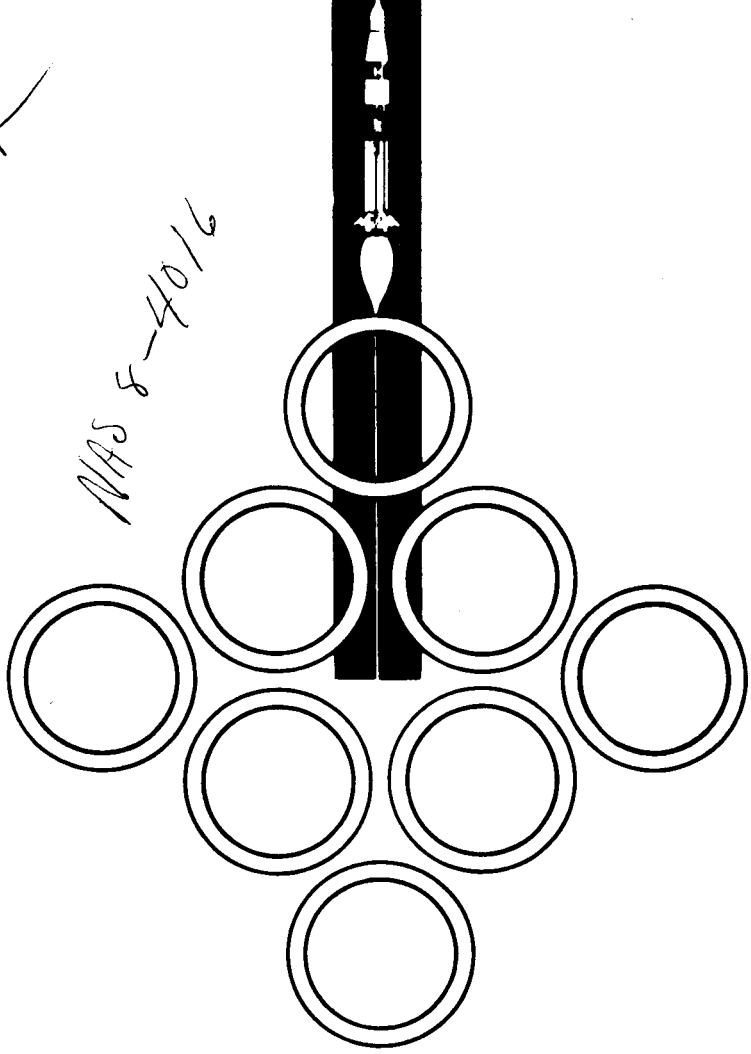

NAS 8-4016

ENGINEERING DEPARTMENT

TECHNICAL REPORT

TR-RE-CCSD-FO-1074-3

February 10, 1967

SATURN IB PROGRAM

TEST REPORT
FOR

BUTTERFLY VALVE, 14-INCH, PNEUMATICALLY OPERATED

Keystone Valve Corporation Series 100, Cylinder 952-2-700-009

NASA Drawing Number 75M04406 PBFV-7

SPACE DIVISION CHRYSLER CORPORATION

TEST REPORT
FOR
BUTTERFLY VALVE, 14-INCH, PNEUMATICALLY OPERATED

Keystone Valve Corporation Series 100, Cylinder 952-2-700-009

NASA Drawing Number 75M04406 PBFV-7

ABSTRACT

This report presents the results of tests performed on one specimen of the Butterfly Valve 75M04406 PBFV-7. The following tests were performed:

1. Receiving Inspection
2. Proof Pressure
3. Functional
4. Flow
5. Surge
6. Low Temperature
7. High Temperature
8. Cycle
9. Burst

The specimen performance was in accordance with specification requirements of NASA drawing 75M04406 PBFV-7 except that slippage occurred three times between the wrench arm and shaft during the cycle test. This discrepancy, caused by inadequate design of the key or keyway, resulted in binding and loss of correlation between the wrench arm and gate position. After resetting, the valve operated smoothly until slippage occurred again.

TP-RE-CCSD-FO-1074-3

TEST REPORT

FOR

BUTTERFLY VALVE, 14-INCH, PNEUMATICALLY OPERATED

Keystone Valve Corporation Series 100, Cylinder 952-2-700-009

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February 10, 1966

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

FOREWORD

The tests reported herein were conducted for the John F. Kennedy Space Center by Chrysler Corporation Space Division (CCSD), New Orleans, Louisiana. This document was prepared by CCSD under contract NAS8-4016, Part VII, CWO 271620.

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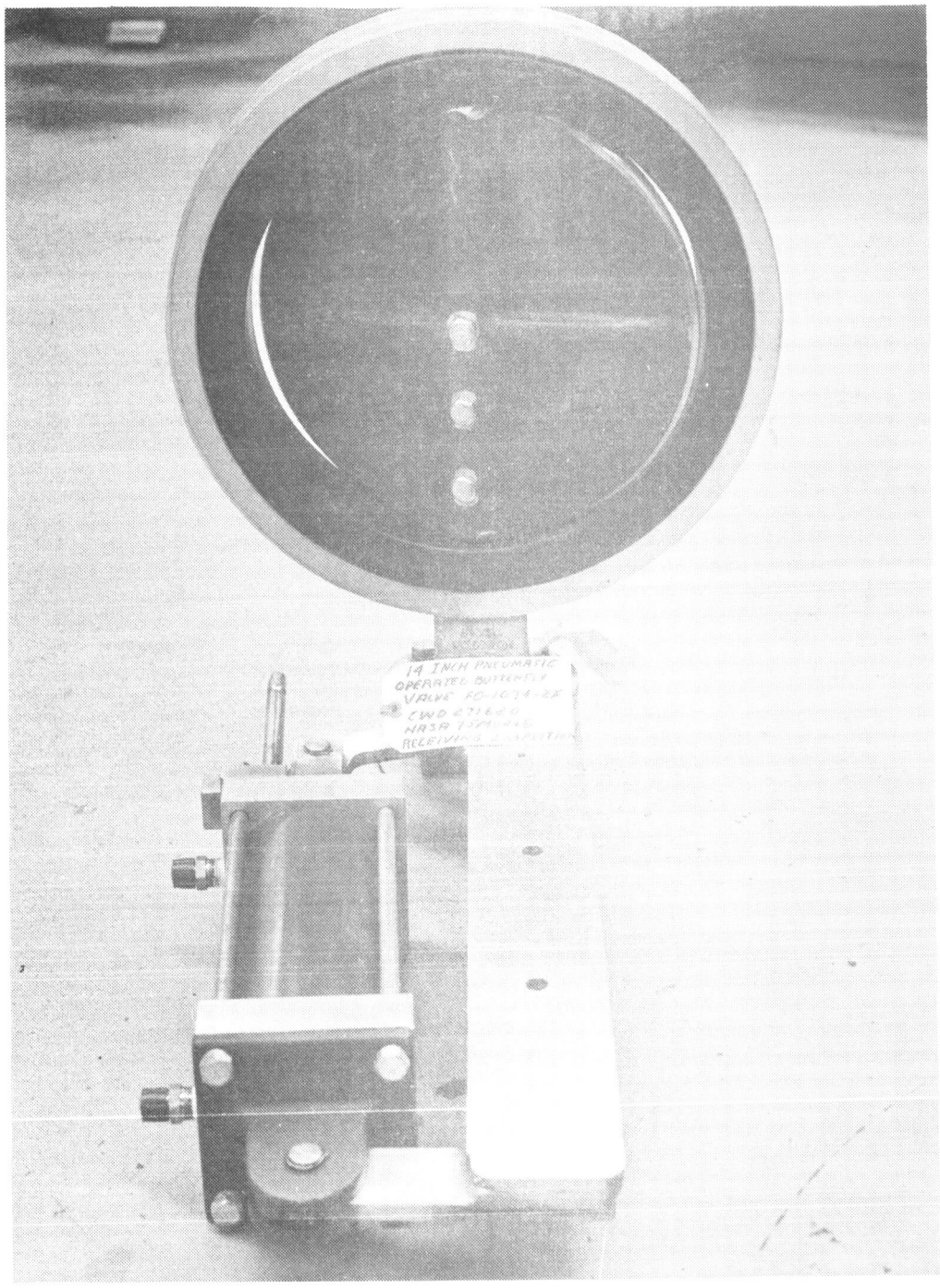


14-Inch, Pneumatically Operated, Butterfly Valve 75MO4406 PBFV-7

CHECK SHEET

FOR

BUTTERFLY VALVE, 14-INCH, PNEUMATICALLY OPERATED

MANUFACTURER: Keystone Valve Corporation
MANUFACTURER'S PART NUMBER: Series 100, Cylinder 952-2-700-009
NASA PART NUMBER: 75M04406 PBFV-7
TESTING AGENCY: Chrysler Corporation Space Division, New Orleans, Louisiana
AUTHORIZING AGENCY: NASA KSC

I. FUNCTIONAL REQUIREMENTS

A. OPERATING MEDIUM: Gaseous nitrogen or air
B. OPERATING PRESSURE: 1. VALVE - 3 psig
2. ACTUATOR - 150 psig
C. PROOF PRESSURE: Valve and actuator to 225 psig
D. BURST PRESSURE: Valve and actuator to 600 psig

II. CONSTRUCTION

A. MATERIALS:

1. VALVE
(A) BODY - Aluminum
(B) DISC - 316 stainless steel, passivated
(C) SHAFT - 316 stainless steel, passivated
(D) SEAT - Neoprene
(E) BUSHINGS - Glass fitted Teflon

2. DOUBLE ACTING CYLINDER
(A) INTERNAL CYLINDER PLATING - chrome plating
(B) ROD - 316 stainless steel, passivated
(C) CLEVIS, WRIST AND LOCKING PINS - 316 stainless steel, passivated
(D) DETENT ROD AND BALL - 316 stainless steel, passivated

III. ENVIRONMENTAL CHARACTERISTICS - MANUFACTURER'S SPECIFICATIONS

A. The temperature range shall be 5 to 160°F.

IV. SPECIAL REQUIREMENTS: The cylinder shall be cleaned per specification A10M01671, level IV, cleaning procedure 3 and 100 per cent tested per method A.

V. LOCATION AND USE: The valve is used in the environmental control system where it acts as a shutoff valve in the redundant air conditioning ducts.

TEST SUMMARY

BUTTERFLY VALVE, 75M04406 PBFV-7

Environment	Units	Operational Boundary	Test Objective	Remarks	Test Results
Receiving Inspection	1	Drawings and specifications	To determine specimen conformance with drawings and specifications		Satisfactory
Proof Pressure Test	1	225 psig	To check for leakage and distortion	112-scim leakage at cap end 5-scim leakage at piston end. No leakage through butterfly ports	Satisfactory
Functional Test	1	Actuator: 150 psig Body: 50 psig	To determine response time and leakage	Open: 630 milliseconds Close: 715 milliseconds No leakage	Satisfactory
Flow Test	1	0 to 5 psig inlet pressures	To determine C_V and flow rate vs pressure drop	C_V = 2003	Satisfactory
Surge Test	1	0 to 50 psig within 100 milliseconds 100 cycles	To determine if specimen operation is impaired by surge pressures		Satisfactory
Low Temperature Test	1	5 (+0,-4)°F	To determine if specimen operation is impaired by low temperature		Satisfactory
High Temperature Test	1	160 (+5, -0)°F 72 hours	To determine if specimen operation is impaired by high temperature		Satisfactory
Life Cycle Test	1	5000 cycles	To determine if specimen operation is impaired by cycling		Satisfactory
Burst Test	1	600 psig for 5 minutes	To determine if specimen will withstand minimum burst pressure	No leakage or distortion	Satisfactory

SECTION I

INTRODUCTION

1.1 SCOPE

This report presents the results of tests that were performed to determine if Butterfly Valve 75M04406 PBFV-7 meets the operational requirements for John F. Kennedy Space Center Launch Complexes 34 and 37B. A summary of the test results is presented on page viii.

1.2 ITEM DESCRIPTION

1.2.1 One specimen of Butterfly Valve 75M04406 PBFV-7 was tested. The valve is manufactured by the Keystone Valve Corporation as series 100. The valve comes complete with a double acting cylinder (vendor part number 952-2-700-009). The valve is used as a shutoff valve in the redundant air conditioning ducts in the environmental control system.

1.2.2 The valve is a 14-inch, pneumatically operated valve designed to operate at 3 psig. The valve body is aluminum, the shaft and disc are stainless steel, the bushings are nylon filled Teflon, and the valve seat is neoprene.

1.3 APPLICABLE DOCUMENTS

The following documents contain the test requirements for Butterfly Valve 75M04406 PBFV-7.

a. KSC-STD-164(D), dated September 17, 1964, Standard Environmental Test Methods for Ground Support Equipment Installations at Cape Kennedy

b. NASA Drawing 75M04406 PBFV-7

c. Cleanliness Requirement A10M01671

d. Test Plan CCSD-FO-1074-1F

e. Test Procedure CCSD-FO-1074-2F

SECTION II

RECEIVING INSPECTION

2.1 TEST REQUIREMENTS

The specimen shall be checked for conformance with NASA drawing number 75M04406 PBFV-7 and applicable specifications to the extent possible without disassembly of the test specimen. The specimen shall also be inspected for poor workmanship and manufacturing defects.

2.2 TEST PROCEDURE

2.2.1 The specimen was checked for conformance with NASA drawing 75M04406 PBFV-7 and for defective threads, welds or poor workmanship.

2.3 TEST RESULTS

The specimen complied with NASA drawing 75M04406 PBFV-7. No evidence of poor workmanship or other manufacturing defects was observed.

2.4 TEST DATA

Receiving inspection test data are shown in table 2-1.

Table 2-1. Receiving Inspection Test Data

Physical Description	Circular valve, double acting cylinder
Valve Material	Aluminum
Disc and Shaft	Stainless steel
Valve Housing O.D.	17-5/8 inches
Butterfly O.D.	13-1/4 inches
Valve Housing Width	2-5/16 inches
Neoprene Seat	15-7/8 inches O.D.; 17-$\frac{1}{2}$ inches I.D.
Cylinder Dimension	Length 12-9/16 inches diameter 4-3/4 inches

Note: This item did not have a serial number.

SECTION III

PROOF PRESSURE TEST

3.1 TEST REQUIREMENTS

3.1.1 The test specimen inlet and outlet shall be subjected to a proof pressure of 225 psig. The pressure shall be applied simultaneously to the inlet and outlet ports of the specimen.

3.1.2 The actuator inlet and outlet shall be subjected to a proof pressure of 225 psig. The pressure shall be applied simultaneously to the inlet and outlet of the actuator.

3.1.3 The proof pressure shall be maintained for 5 minutes.

3.1.4 The specimen and actuator shall be checked for leakage and distortion during this test.

3.2 TEST PROCEDURE

3.2.1 The proof pressure test setup was assembled as shown in figure 3-1 (installation A) and figure 3-2 using the equipment listed in table 3-1.

3.2.2 All hand valves were closed and regulator 6 was adjusted to zero outlet pressure.

3.2.3 Normally closed solenoid valves 9 and 10 were opened by simultaneously energizing each valve.

3.2.4 Hand valve 3 was opened. The reading on gage 5 was 3200 psig.

3.2.5 Regulator 6 was adjusted to provide a pressure of 225 psig as read on gage 7. This pressure was applied simultaneously to the inlet ports of the specimen.

3.2.6 The 225-psig proof pressure was maintained for 5 minutes while the specimen was checked for leakage and distortion.

3.2.7 Hand valve 3 was closed and hand valve 8 was slowly opened to vent the system.

3.2.8 Hand valve 8 was closed.

3.2.9 Solenoid valves 9 and 10 were closed by de-energizing each valve.

3.2.10 Solenoid valves 9 and 10 were connected to each end of the actuator as shown in figure 3-1 (installation B).

3.2.11 The procedures described in 3.2.4 through 3.2.7 were repeated to apply the proof pressure to the actuator.

3.2.12 All data were recorded.

3.3 TEST RESULTS

3.3.1 The test specimen did not leak or show signs of distortion when the inlet and outlet ports were pressurized to 225 psig.

3.3.2 Leakage existed around the end plates of the actuator when the openings were pressurized to 225 psig.

3.4 TEST DATA

3.4.1 Test data are presented in tables 3-2 and 3-3.

Table 3-1. Proof Pressure Test Equipment List

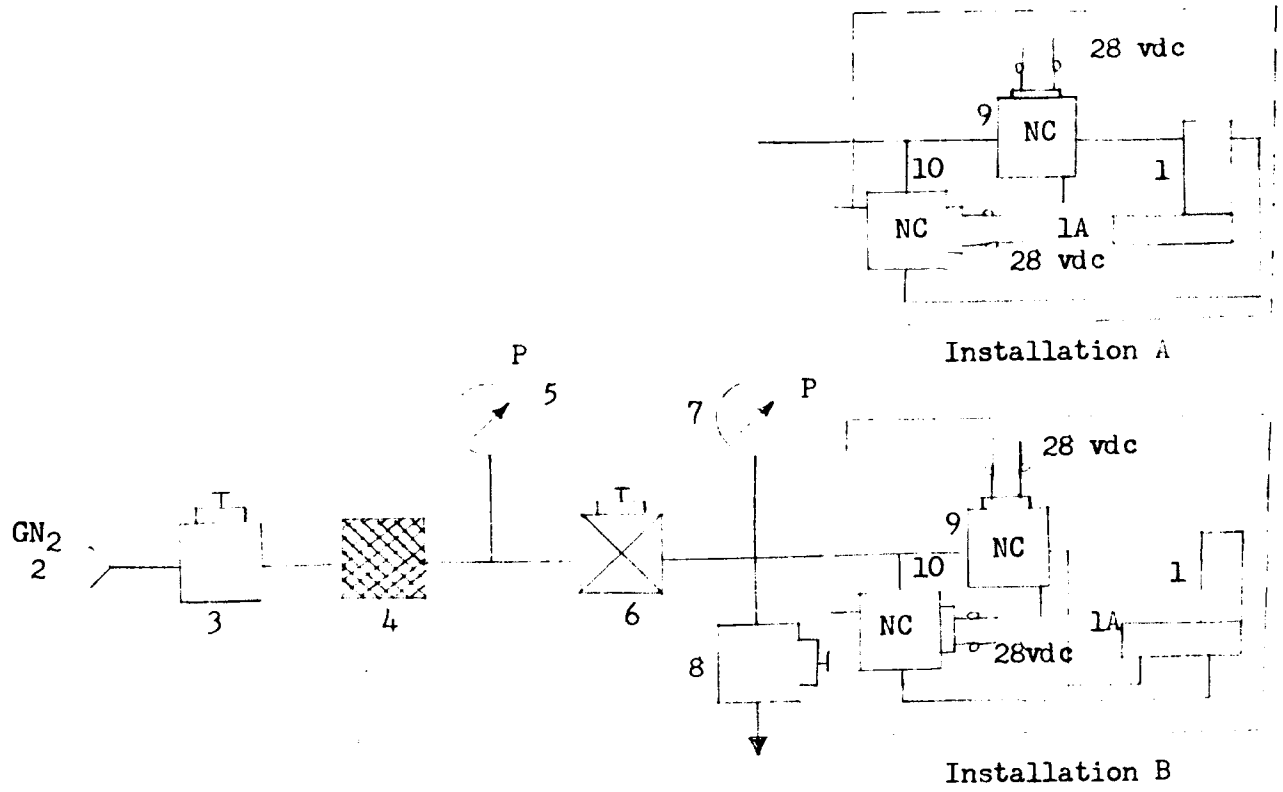
Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Keystone Valve Corporation	100	NA	Butterfly valve, 14-inch
1A	Specimen Actuator		6325	NA	Cylinder
2	GN_2 Supply	CCSD	NA	NA	3000-psig
3	Hand Valve	Combination Pump Valve Company	380-4	NA	1-½-inch
4	Filter	Bendix	1730130	25-13460-16-8-0	2-micron
5	Pressure Gage	Ashcroft	NA	NASA 200616-I	0-to 5000-psig ±2% FS accuracy Cal date 8-2-66
6	Pressure Regulator	Tescom Corp.	26-1003	1005	3000-psig inlet 0-to 300-psig outlet
7	Pressure Gage	Ashcroft	NA	NASA 200594-H	0-to 500-psig ±0.5% accuracy Cal date 8-2-66
8	Hand Valve	Robbins Aviation, Inc.	SSKG-250 4T	NA	¼-inch
9	Solenoid Valve	Marotta Valve Corp.	MV-583	2885	½-inch, 3-way normally closed 0-to 6000-psig
10	Solenoid Valve	Marotta Valve Corp.	MV-583	8696	½-inch, 3-way normally closed 0-to 6000-psig

Table 3-2. Leakage with Inlet and Outlet Ports Simultaneously Pressurized

Pressure (psig)	Leakage
225	None

Table 3-3. Actuator Leakage Data Obtained with Inlet and Outlet Ports Simultaneously Pressurized

Pressure (psig)	Leakage at Inlet Plate End (scim)	Leakage at Outlet Plate End (scim)
225	112	5



Note: All lines 1/4 inch.
See table 3-1 for item identification.

Figure 3-1. Proof Pressure Test Schematic

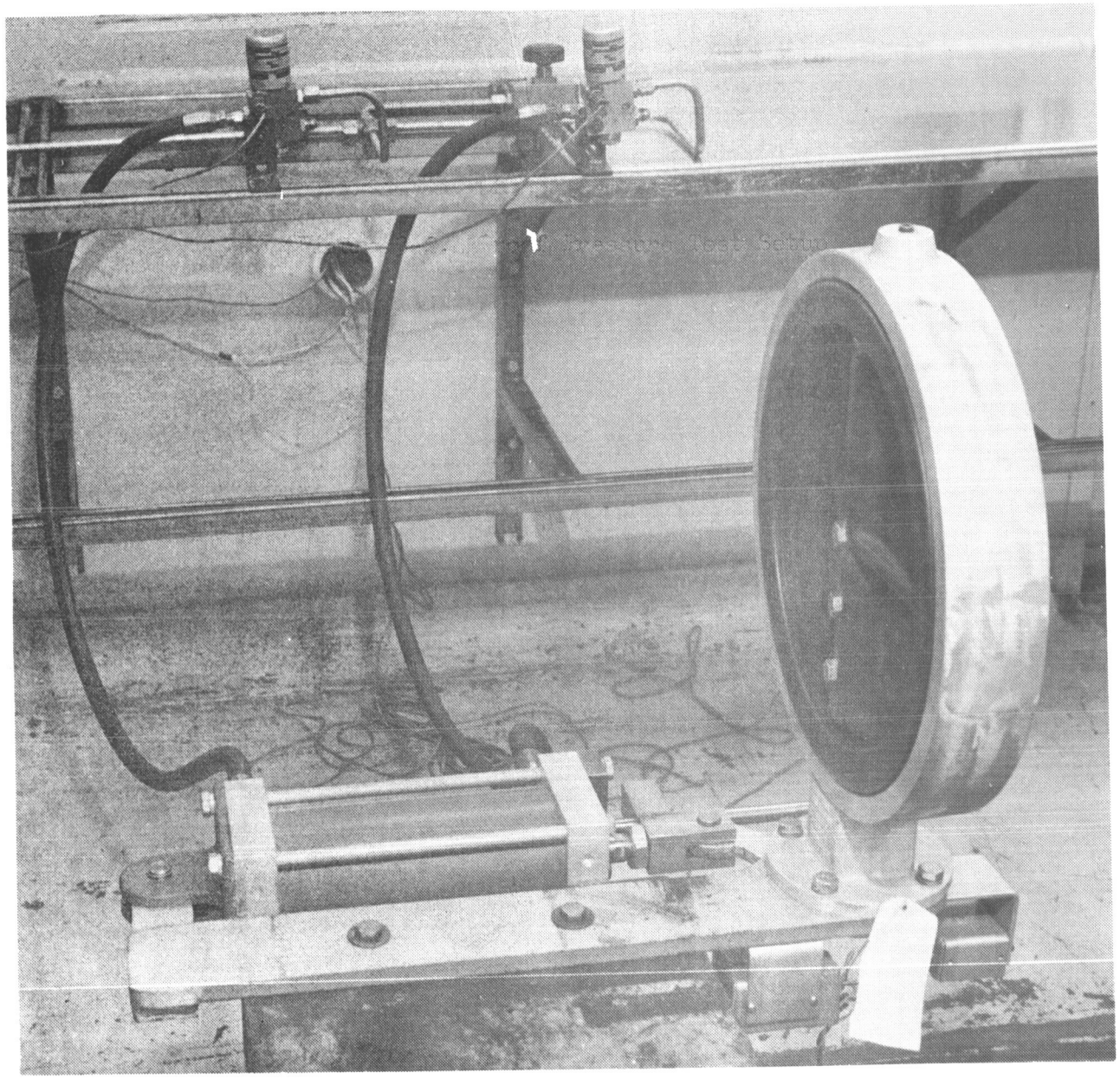


Figure 3-2. Proof Pressure Test Setup

SECTION IV

FUNCTIONAL TEST

4.1 TEST REQUIREMENTS

4.1.1 The test specimen shall be functionally tested for full opening and full closing response time. Data shall be recorded.

4.1.2 The test specimen shall be tested for leakage. Data shall be recorded.

4.2 TEST PROCEDURE

4.2.1 The functional test setup was assembled as shown in figure 4-1 (installation A), and figure 4-2 using the equipment listed in table 4-1.

4.2.2 All hand valves were closed and all regulators were adjusted for zero outlet pressure.

4.2.3 Hand valve 2 was opened.

4.2.4 The reading on gage 4 was 3200 psig.

4.2.5 Regulator 5 was adjusted to establish 150 psig as indicated on pressure gage 6.

4.2.6 Hand valve 8 was opened. The 150-psig pressure, routed to actuator 1A through normally open solenoid valve 14, caused the actuator to open specimen 1.

4.2.7 Switch 16 was closed and solenoid valves 14 and 15 were energized. Solenoid valve 14 was closed and the opening side of actuator 1A was vented. Normally closed solenoid valve 15 was opened and the 150-psig pressure, routed to the actuator, caused the specimen to close. Oscillograph recorder 24 was used to record the time required for the specimen to reach the fully closed position.

4.2.8 Switch 16 was opened to de-energize solenoid valves 14 and 15. Solenoid valve 15 returned to the closed position and vented the closing side of actuator 1A. Solenoid valve 14 returned to the open position and the 150-psig pressure caused the specimen to open . Oscillograph recorder 24 was used to record the time required for the specimen to reach the fully open position.

4.2.9 The procedures described in 4.2.7 and 4.2.8 were repeated five times for the initial functional test and three times for each subsequent functional test.

4.2.10 Switch 16 was closed and regulator 22 was adjusted to establish 50 psig on pressure gage 11.

4.2.11 Hand valve 17 was opened.

4.2.12 Hand valve 12 was slowly opened to apply 50 psig to the specimen inlet.

4.2.13 Water tank 19 was monitored for bubbles.

4.2.14 The amount of bubble leakage was determined by the water displacement in beaker 9. The leakage data were recorded.

4.2.15 Hand valve 12 was closed.

4.2.16 Hand valve 13 was opened.

4.2.17 The functional test setup was assembled as shown in figure 4-1 (installation B).

4.2.18 Hand valve 13 was closed.

4.2.19 Hand valve 12 was slowly opened to apply 50 psig to the specimen outlet.

4.2.20 The procedures described in 4.2.14 and 4.2.15 were repeated.

4.2.21 All test data were recorded.

4.3 TEST RESULTS

4.3.1 The opening time of the valve when the actuator was pressurized to 150 psig, was 635 milliseconds and the closing time was 715 milliseconds. No leakage occurred when the inlet and outlet ports were simultaneously pressurized to 50 psig.

4.3.2 The test results were satisfactory.

4.4 TEST DATA

Test data are presented in table 4-2.

Table 4-1. Functional Test Equipment List

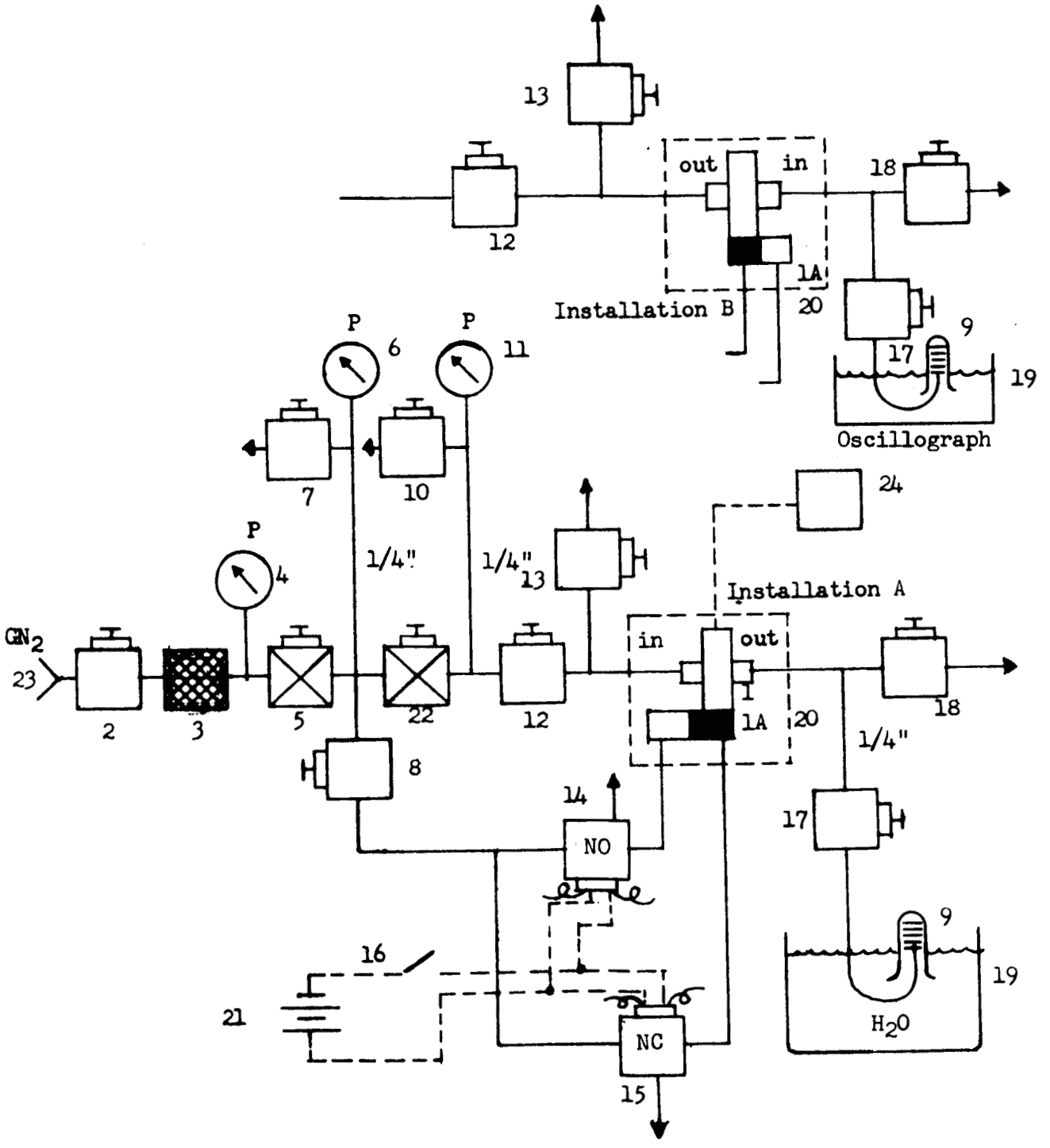
Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Keystone Valve Corp.	100	NA	Butterfly valve, 14-inch
1A	Specimen Actuator	NA	6325	NA	Cylinder
2	Hand Valve	Combination Pump and Valve Co.	380-4	NA	1-½-inch
3	Filter	Bendix	1730130	25-13460-16-8-0	2-micron
4	Pressure Gage	Ashcroft	NA	200616-L	0-to 5000-psig, ±2% FS accuracy Cal date 8-2-66
5	Regulator	Tescom Corp.	26-1003	1005	3000-psig inlet
6	Pressure Gage	Ashcroft	NA	200594-H	0-to 500-psig, ±0.25% FS accuracy Cal date 8-2-66
7	Hand Valve	Robbins Aviation, Inc.	SSKG-250 4T	NA	¼-inch
8	Hand Valve	Robbins Aviation, Inc.	SSKG-357B 8T-768	NA	¼-inch
9	Beaker	CCSD	NA	NA	For leakage measurement
10	Hand Valve	Robbins Aviation, Inc.	SSKG-250 4T	NA	¼-inch
11	Pressure Gage	Ashcroft	NA	200616-Q	160-psig, ±0.25% FS accuracy Cal date 8-2-66
12	Hand Valve	Robbins Aviation, Inc.	SSKG-375B 8T-12	NA	½-inch
13	Hand Valve	Robbins Aviation, Inc.	SSKG-250 4T	NA	½-inch

Table 4-1. Functional Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
14	Solenoid Valve	Marotta Valve Corp.	MV 121	115	½-inch, 3-way, normally open
15	Solenoid Valve	Marotta Valve Corp.	MV 58	356	1-inch, 3-way, normally closed
16	Switch	Cutler Hammer, Co.	420E-20L 1732	NA	SPST
17	Hand Valve	Robbins Aviation, Inc.	SSKG-250-4T	NA	¼-inch
18	Hand Valve	Robbins Aviation, Inc.	SSKG-250-4T	NA	¼-inch
19	Water Tank	CCSD	NA	NA	Tap water
20	Thermal Chamber	Conrad	NA	200922	0 to 160°F (For temperature test only)
21	Power Supply	CCSD	NA	NA	28-vdc
22	Regulator	Tescom Corp.	26-1003	1005	500-psig inlet 0-to 100-psig outlet
23	Source	Air Products	NA	NA	3000-psig
24	Oscillograph	CEC	NASA 017887	NA	Cal date 9-22-66

Table 4-2. Initial Functional Test Data

Run	Applied Pressure (psig)	Response Time (MS) Opening	Closing	Seat Leakage (scim) Inlet Port	Outlet Port
1	-	669	653	-	-
2	-	614	746	-	-
3	-	575	785	-	-
4	-	625	700	-	-
5	-	640	708	-	-
	50	-	-	0	0



Note: All lines 1/2 inch unless otherwise specified.
Refer to table 4-1 for item identification.

Figure 4-1. Functional Test Schematic

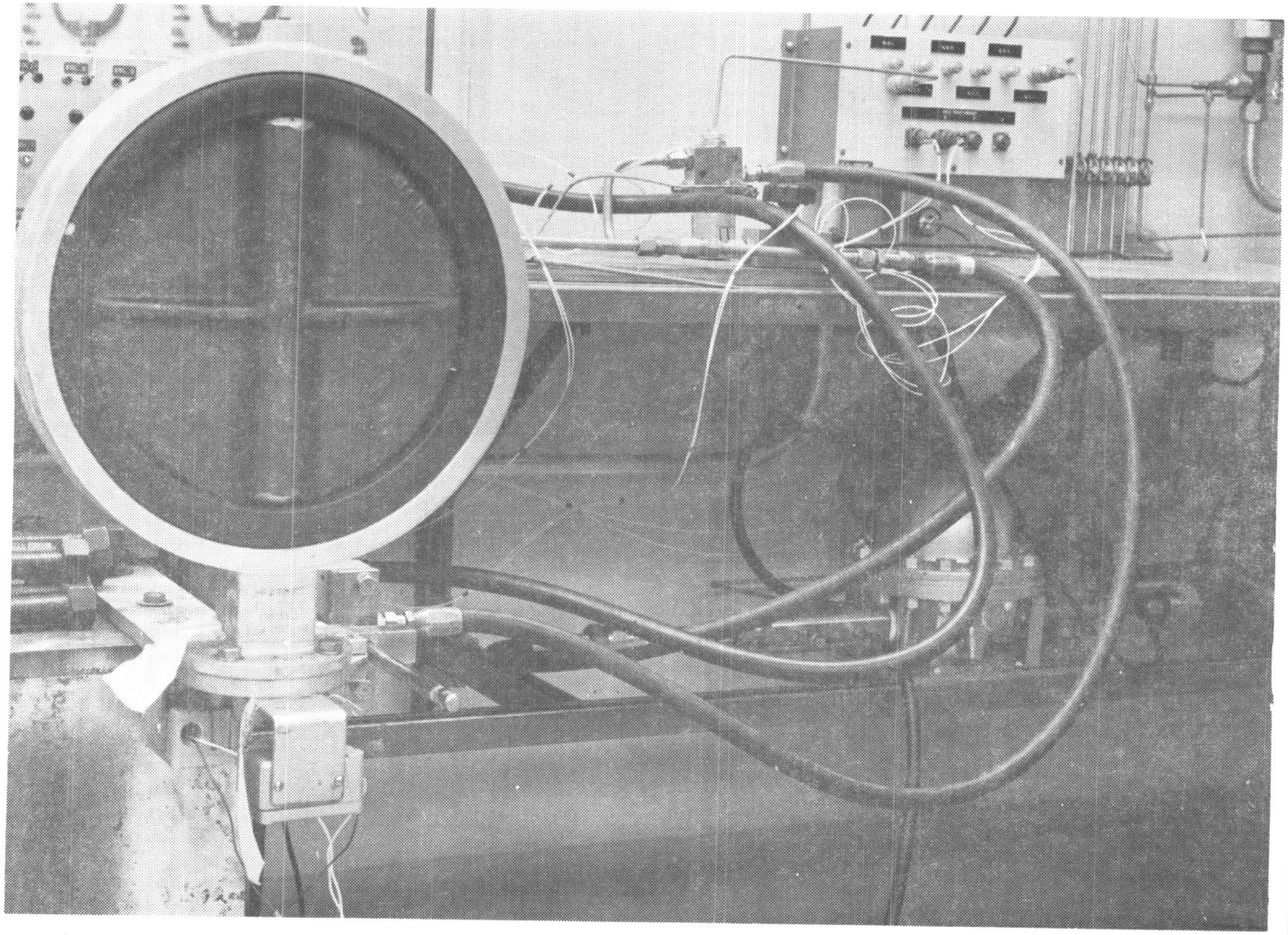


Figure 4-2. Functional Test Setup

SECTION V

FLOW TEST

5.1 TEST REQUIREMENTS

5.1.1 A flow test shall be performed on the test specimen.

5.1.2 A flow rate versus pressure drop curve shall be developed.

5.1.3 The capacity (Cv) of the valve shall be determined.

5.2 TEST PROCEDURE

5.2.1 The flow test setup was assembled as shown in figures 5-1 and 5-2 using the equipment listed in table 5-1.

5.2.2 A functional test was performed because 72 hours had elapsed since the previous functional test.

5.2.3 All hand valves were closed and all regulators were adjusted for zero outlet pressure.

5.2.4 Hand valve 3 was opened.

5.2.5 The reading on pressure gauge 21 was 3200 psig.

5.2.6 Regulator 9 was adjusted to establish 150 psig on pressure gage 20 and actuator 1A. This pressure on actuator 1A caused the specimen to open.

5.2.7 Hand valve 18 was opened.

5.2.8 Regulator 5 was adjusted to establish a pressure of 1 psig at the test specimen inlet. This pressure was monitored by pressure gage 16.

5.2.9 The pressures indicated on pressure gages 10, 13, and 16 and manometer 17 were recorded.

5.2.10 The temperature indicated on thermocouples 11 and 14 were recorded.

5.2.11 The flow rate through flowmeter 12 was calculated for the recorded inlet pressure and temperature.

5.2.12 Regulator 5 was adjusted to increase specimen inlet pressure 1 psig as indicated on pressure gage 16.

5.2.13 The procedures described in 5.2.8 through 5.2.11 were repeated for five pressure increases.

5.2.14 A curve was developed for specimen flow rate versus pressure drop.

5.2.15 The specimen C_v was calculated from the following equation.

$$C_v = \frac{Q\sqrt{GT}}{963\sqrt{P(P_1 + P_2)}}$$

Where:

G = Gas specific gravity (air = 1.0 at standard conditions)

Q = Gas flow (SCFH)

P_1 = Pressure upstream of valve (psia)

P_2 = Pressure downstream of valve (psia)

P = Pressure drop (psid)

T = Gas temperature, °R

5.2.16 A functional test was performed within 1 hour after completion of the flow test.

5.3 TEST RESULTS

5.3.1 The pressure drop through the specimen at 5330 scfm was 0.83 psid. Valve capacity (C_v) at 5330 scfm was 2003.

5.3.2 The test results were satisfactory.

5.4 TEST DATA

5.4.1 Test data are presented in table 5-2. Functional test data obtained before the flow test (72-hour time lapse since last functional) and functional test data obtained after the flow test are shown in table 5-3. No leakage occurred during the functional test when the inlet and outlet ports were alternately pressurized at 50 psig. Actual flow rate versus pressure drop is presented in figure 5-3.

Table 5-1. Flow Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Keystone Valve Corp.	100	NA	Butterfly valve, 14-inch
1A	Specimen Actuator		6325	NA	Cylinder
2	GN_2 Supply	CCSD	NA	NA	3000-psig
3	Hand Valve	Calmec Valve Co.	176-65	NA	1-½-inch
4	Filter	Bendix	5-S-13460-16-8-0	24	2-micron
5	Regulator	Tescom Corp.	26-1002-21	3485	3000-psig inlet 0-to 2000-psig outlet
6	Regulator	Grove	WH-408-N4	RA-5922	Dome loading type, 3000-psig inlet, 0-to 2000-psig outlet
7	Pressure Gage	Hiese	NA	NASA 015532	0-to 1000-psig ±25% FS accuracy Cal date 10-27-66
8	Hand Valve	Robbins Aviation, Inc.	NA	NA	¼-inch
9	Regulator	Tescom Corp.	26-1002	1010	3000-psig inlet 0-to 200 psig outlet
10	Pressure Gage	Hiese	NA	NASA 014224	0-to 3000-psig, ±0.25% FS accuracy Cal date 8-18-66
11	Thermocouple and Temperature Gage	West	NA	NASA 019454	-100 to +400°F ±2.5°F Cal date 7-20-66
12	Flowmeter	Flow Dyne	NA	2524	Critical nozzle

Table 5-1. Flow Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
13	Pressure Gage	Hiese	NA	NASA 014226	0-to 100-psig ±0.25% FS accuracy Cal date 8-26-66
14	Thermocouple	Minneapolis Honeywell	NA	NA	-75-to + 150°F
15	Ullage Tank	CCSD	NA	NA	500-cubic foot
16	Pressure Gage	Heise	NA	95-1376-B	0-to 60-psig, ±0.25% FS accuracy Cal date 8-13-66
17	Manometer	Meridith Co.	237323	NASA 95-1629-B	0-to 60 inches H_2O Cal date 6-28-66
18	Gate Valve	Crane Co.	67053	125S	12-inch
19	Hand Valve	Robbins Aviation, Inc.	SSKG-375B 87-B		½-inch
20	Pressure Gage	Marsh Instrument Co.	NA	NASA 951151-B	0-to 200-psig ±0.25% FS accuracy Cal date 8-4-66
21	Pressure Gage	Ashcroft	NA	NASA 109-1002 B	0-to 5000-psig ±0.25% FS accuracy Cal date 10-5-66

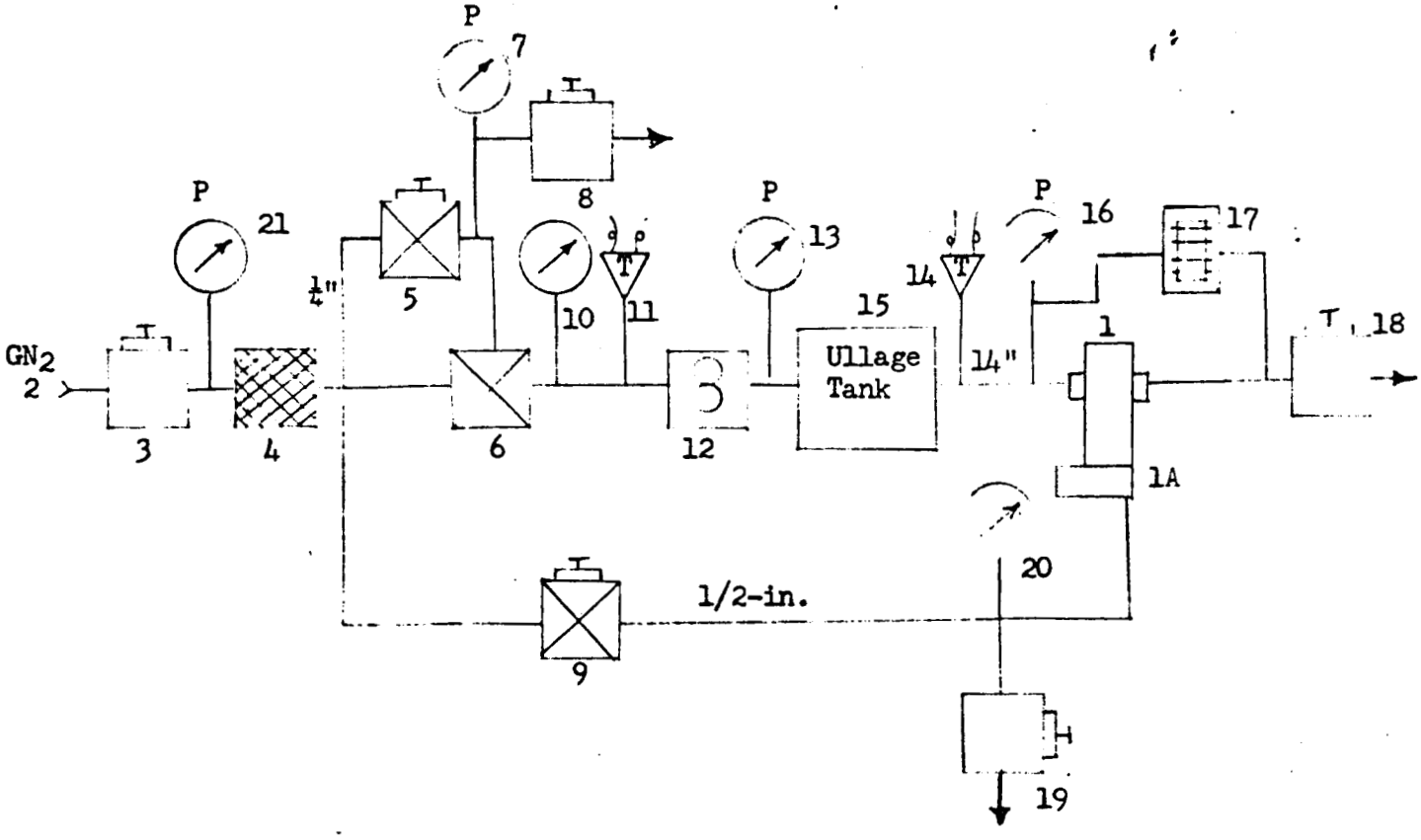
Table 5-2. Flow Test Data

Pressure Reading; upstream of specimen (psi)	T (°R)	G	$P_1 + P_2$ (psia)	P (psid)	Q (scfh)	C_V
1	525	.967	31.25	0.15	136800	1480
2	508	.967	33.05	0.35	190800	1290
3	495	.967	34.93	0.47	228000	1280
4	495	.967	36.75	0.65	267000	1240
5	495	.967	38.57	0.83	319800	1280

Note: T = 460 + °F
G = Gas Specific Gravity
P_1 = Inlet Pressure
P_2 = Outlet Pressure
P = Pressure Drop Across Valve
Q = Flow Cubic Feet Per Hour
C_V = Valve Capacity

Table 5-3. Flow Test Data (Functional)

Time of Run	Run	Applied Pressure (psig)	Response Time (ms)		Seat Leakage (scim)	
			Opening	Closing	Inlet Port	Outlet Port
Before Flow Test	1	-	580	640	-	-
	2	-	520	632	-	-
	3	-	533	660	-	-
		50			0	0
After Flow Test	1	-	400	590	-	-
	2	-	450	572	-	-
	3	-	430	570	-	-
		50	-	-	0	0



Note: All lines 1 inch unless otherwise specified.
Refer to table 5-1 for item identification.

Figure 5-1. Flow Test Schematic

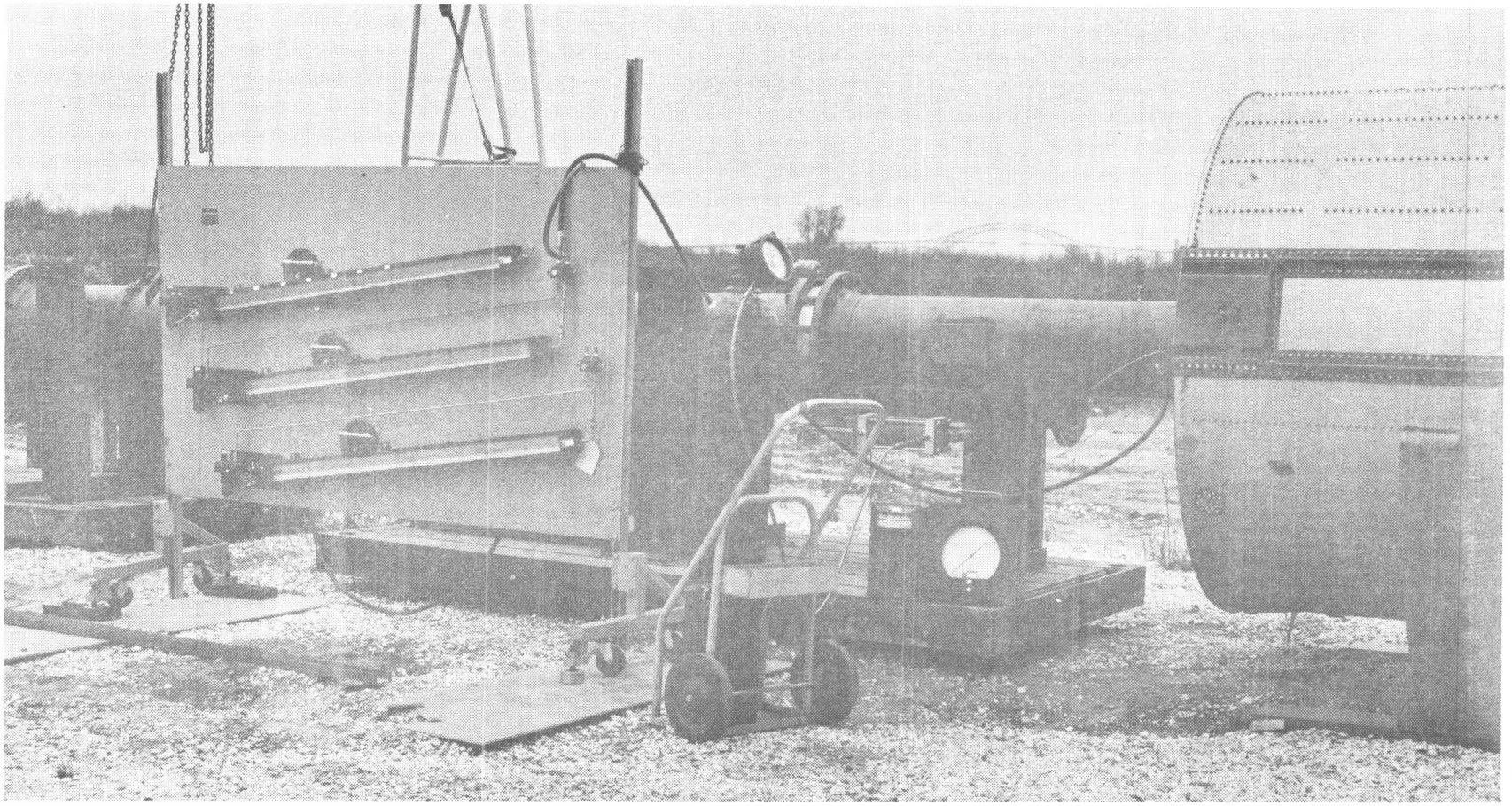


Figure 5-2. Flow Test Setup

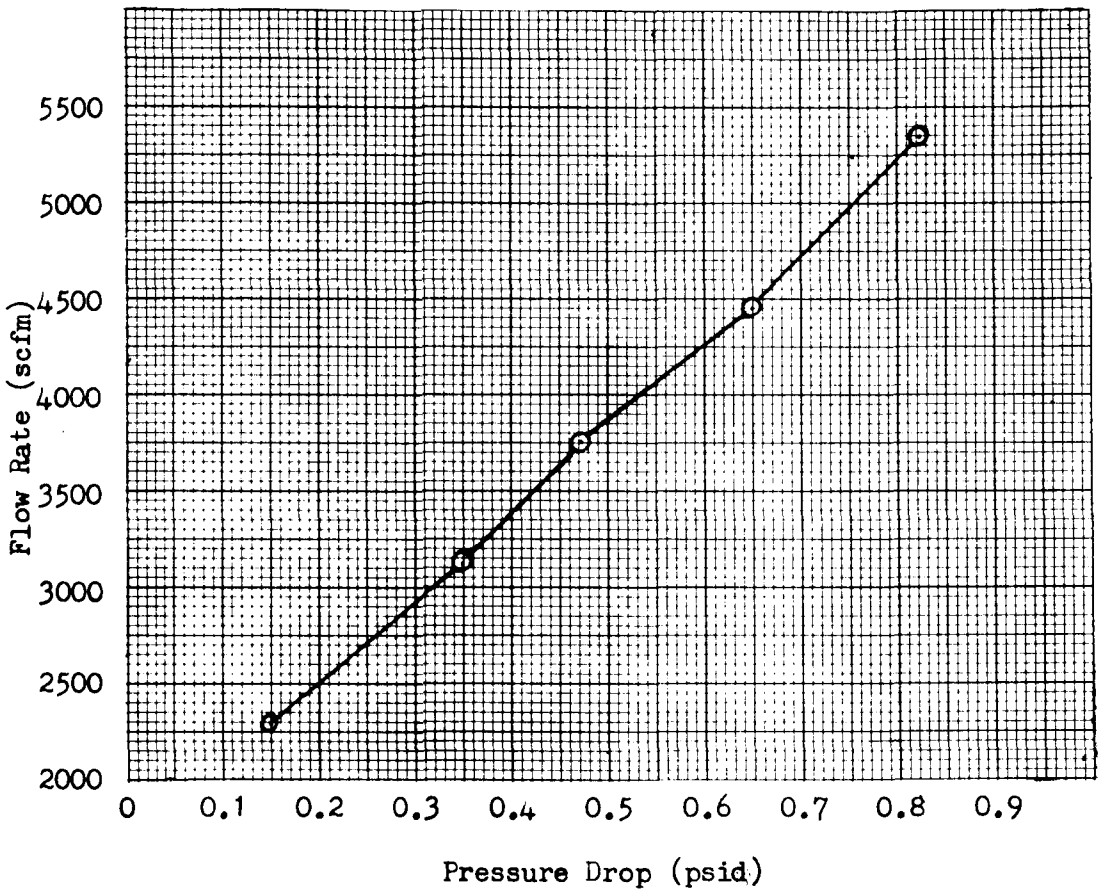


Figure 5-3. Flow Rate Versus Pressure Drop

SECTION VI

SURGE TEST

6.1 TEST REQUIREMENTS

6.1.1 The test specimen shall be subjected to 100 pressure surges.

6.1.2 Each pressure surge shall be a pressure increase from zero to 50 psig within 100 milliseconds. The valve shall be in the fully closed position.

6.1.3 A functional test, as specified in section IV, shall be performed following the surge test.

6.2 TEST PROCEDURE

6.2.1 The surge test setup was assembled as shown in figures 6-1 and 6-2 using the equipment listed in table 6-1.

6.2.2 A functional test was performed since more than 62 hours has elapsed since the previous functional test.

6.2.3 All hand valves were closed and pressure regulators 5 and 8 were adjusted for zero outlet pressure.

6.2.4 Hand valve 2 was opened.

6.2.5 The reading on pressure gage 4 was 3200 psig.

6.2.6 Regulator 5 was adjusted to establish a 150-psig outlet pressure as indicated on pressure gage 7.

6.2.7 Hand valve 11 was slowly opened to apply pressure to the actuator and to close the specimen.

6.2.8 Regulator 8 was adjusted to establish 50-psig outlet pressure as indicated on pressure gage 10.

6.2.9 Oscillograph recorder 17 was started.

6.2.10 Switch 13 was closed and solenoid valve 12 was energized. The switch was held in the closed position until pressure switch 14 actuated and de-energized solenoid valve 12.

6.2.11 Switch 13 was released after pressure switch 14 was actuated.

6.2.12 Hand valve 18 was opened to vent the specimen.

6.2.13 Hand valve 18 was closed.

6.2.14 Regulator 8 was adjusted to obtain the desired surge pressure increase from zero to 50 psig within 100 milliseconds. The pressure surge was monitored with recorder 17.

6.2.15 After the required surge waveform was established, the procedures described in 6.2.10 through 6.2.13 were repeated 100 times.

6.2.16 A functional test was performed after completion of the surge test.

6.2.17 The test data were recorded.

6.3 TEST RESULTS

The specimen successfully withstood surge testing. No degradation in performance was noted.

6.4 TEST DATA

6.4.1 A typical surge waveform is presented in figure 6-3.

6.4.2 Functional test data obtained before the surge test and after the surge test are presented in table 6-2.

Table 6-1. Surge Test Equipment List

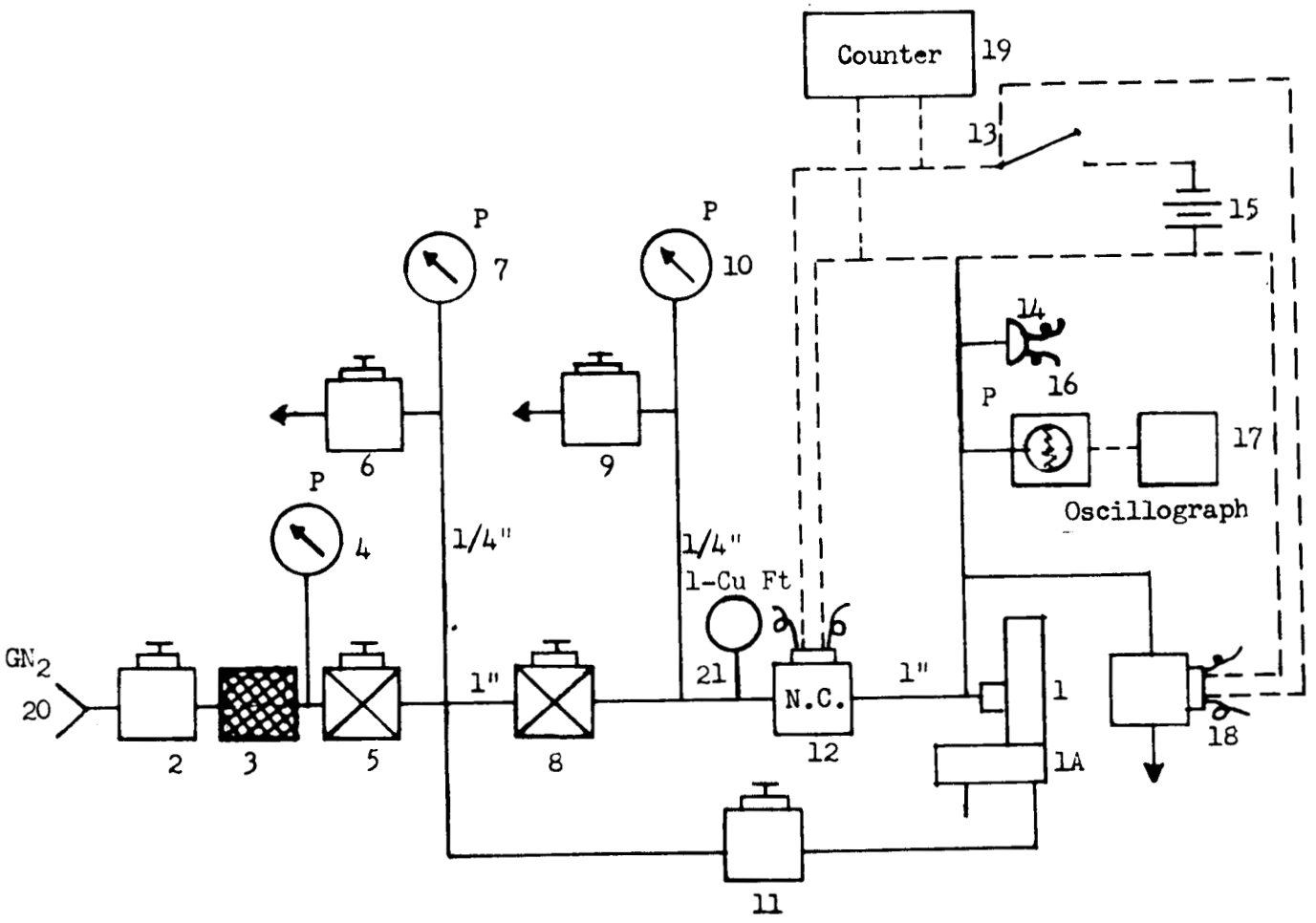
Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Keystone Valve Corp.	100	NA	Butterfly valve, 14-inch
1A	Specimen Actuator		6325	NA	Cylinder
2	Hand Valve	Combination Pump and Valve Co.	NA	NA	1-½-inch 0-to 4000-psig
3	Filter	Bendix	1730130	25-13460 16-8-0	5-micron
4	Pressure Gage	Ashcroft	NA	NASA 200616-L	0-to 5000-psig ±2% FS accuracy Cal date 11-3-66
5	Regulator	Tescom Corp.	26-1003	1005	3000-psig inlet 0-to 4000-psig outlet
6	Hand Valve	Robbins Aviation, Inc.	SSKG-250 4T	NA	¼-inch
7	Pressure Gage	Ashcroft	NA	NASA 200616-C	0-to 1500-psig ±0.25% FS accuracy Cal date 11-3-66
8	Regulator	Tescom Corp.	26-1003	1006	500-psig inlet 0-to 500-psig outlet
9	Hand Valve	Robbins Aviation Inc.	SSKG-250-4T	NA	¼-inch
10	Pressure Gage	Ashcroft	NA	NASA 200616-Q	0-to 150-psig ±0.25% FS accuracy Cal date 11-3-66
11	Hand Valve	Robbins Aviation, Inc.	SSKG-375B 8T-12	NA	½-inch
12	Solenoid Valve	Marotta	MV-121	115	1-inch, normally closed

Table 6-1. Surge Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
13	Switch	Cutler Hammer Co.	NA	NA	2-position, spring-loaded, normally open
14	Pressure Switch	Barksdale Valves	420E-20L-1732	NA	Actuates at 50 psig, normally closed
15	Power Supply	CCSD	NA	NA	28-vdc
16	Pressure Transducer	CEC	NA	3282	0-to 500-psig ±0.25% FS accuracy Cal date 11-3-66
17	Oscillograph Recorder	CEC	NA	NASA 017887	Cal date 9-22-66
18	Hand Valve	Robbins Aviation Inc.	SSKG-250 4T	NA	¼-inch
19	Counter	Durant	NA	NA	4-digit
20	GN_2 Source				3000-psig
21	Sphere	CCSD	NA	NA	1-cubic-foot fiberglass

Table 6-2. Surge Test Data

Time of Run	Run	Applied Pressure (psig)	Response Time (ms)		Seat Leakage (scim)	
			Opening	Closing	Inlet Port	Outlet Port
Before Flow Test	1		400	590		
	2		450	572		
	3		430	570		
		50			0	0
After Surge Test	1		450	668		
	2		484	625		
	3		490	573		
		50			0	0



Note: All lines 1/2 inch unless otherwise specified.
Refer to table 6-1 for item identification.

Figure 6-1. Surge Test Schematic

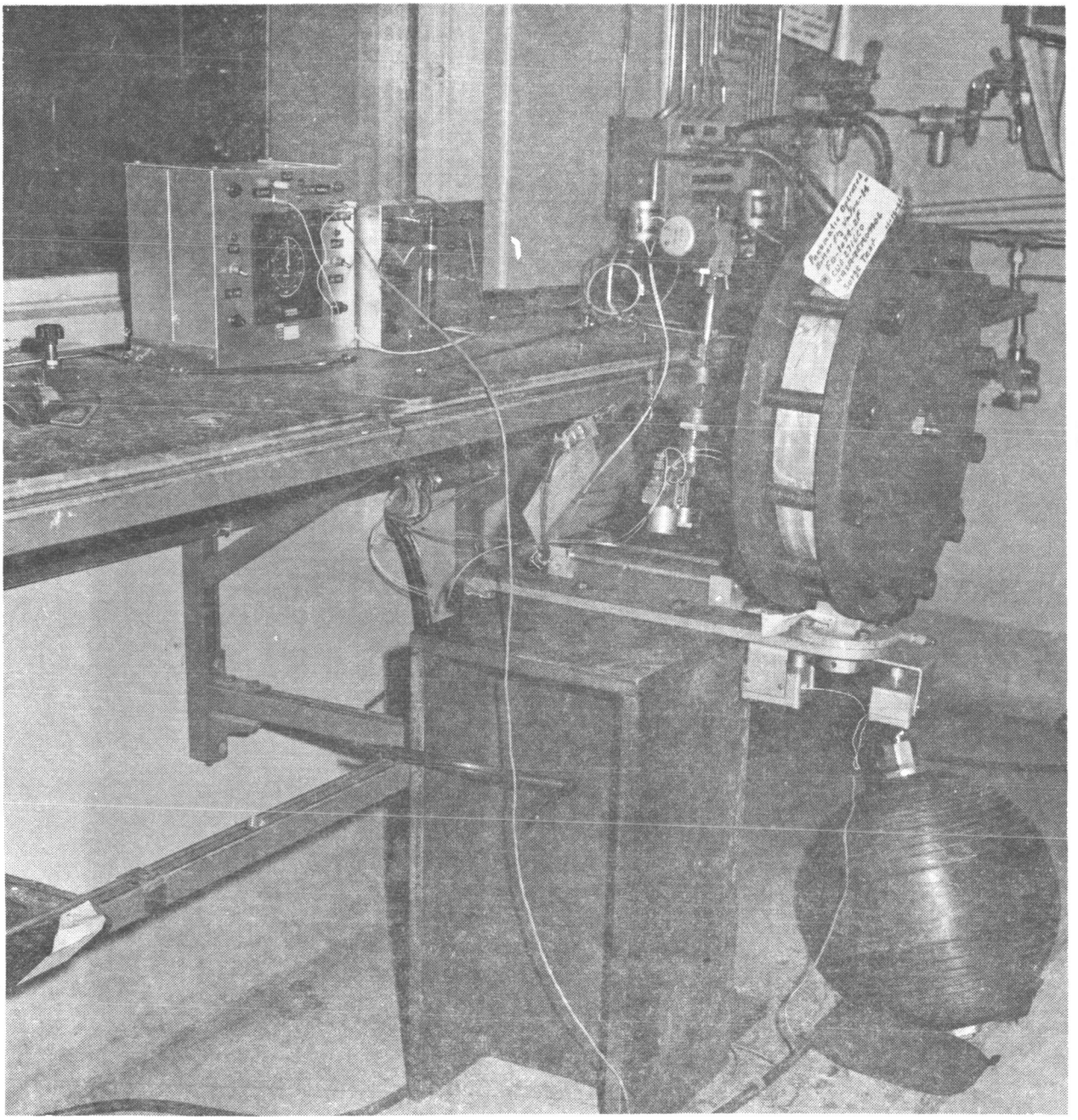


Figure 6-2. Surge Test Setup

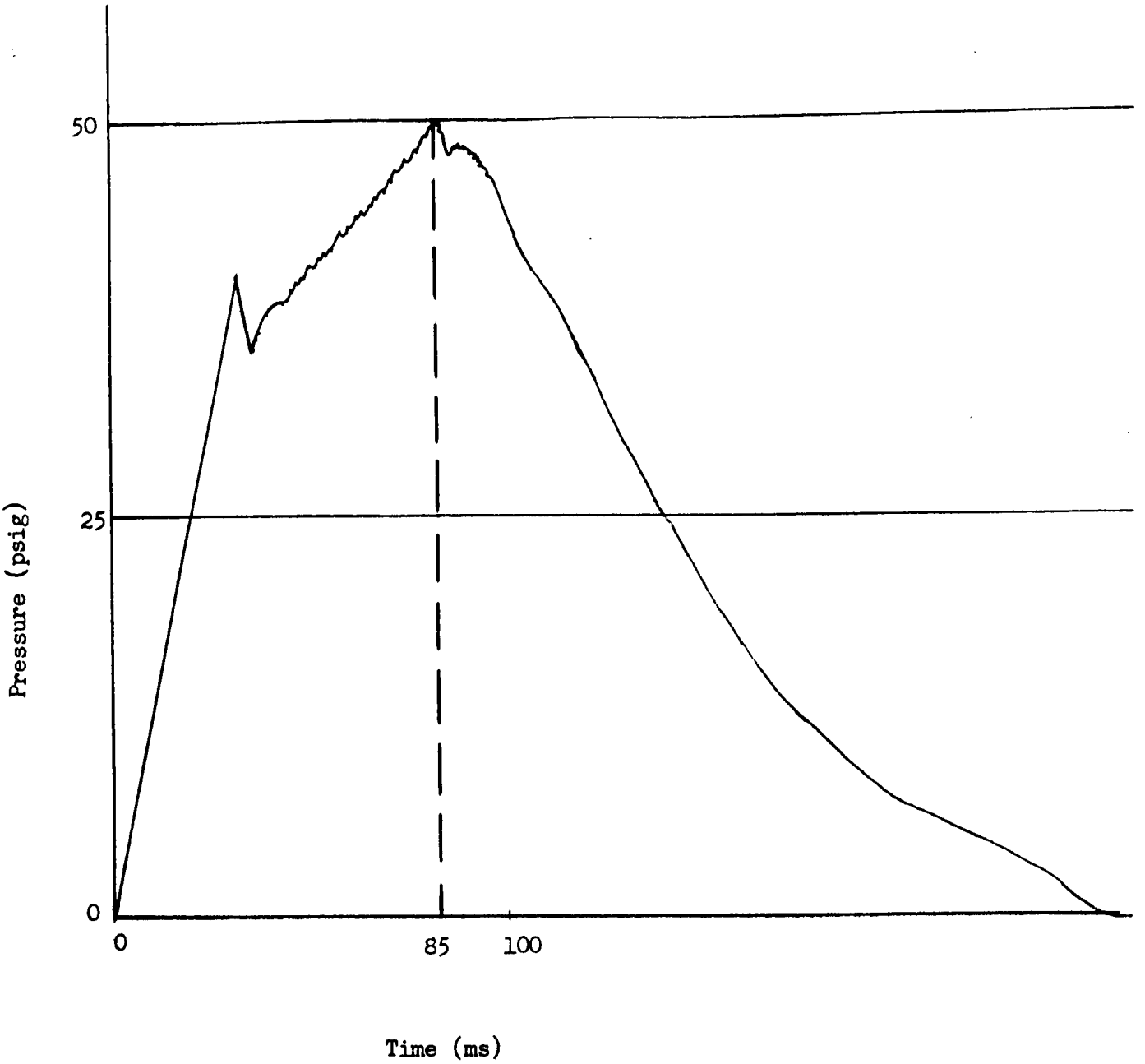


Figure 6-3. Typical Surge Waveform

SECTION VII

LOW TEMPERATURE TEST

7.1 TEST REQUIREMENTS

7.1.1 A low temperature test will be performed on the test specimen to determine whether the environment causes degradation or deformation.

7.1.2 The rated low temperature is 5(+0, -4)°F. Maximum temperature change rate shall be 1° per minute.

7.1.3 A functional test shall be performed during this test.

7.2 TEST PROCEDURE

7.2.1 The test specimen was placed in a temperature chamber using the test setup shown in figure 4-1 (installation A or B as required), and figure 7-1 and the equipment listed in table 4-1.

7.2.2 Chamber 20 was cooled to 5°(+0, -4)°F, maintaining a relative humidity between 60 and 90 per cent. A maximum temperature change rate of 1° per minute was maintained.

7.2.3 A functional test was performed when temperature stabilization was obtained. Temperature stabilization is defined as a maximum temperature change rate of 4°F per hour as determined from the instrumentation monitoring the test specimen.

7.2.4 The chamber temperature was returned to ambient conditions upon completion of the functional test.

7.2.5 The specimen was visually inspected and functionally tested within 1 hour following the return to ambient conditions.

7.2.6 The test data were recorded.

7.3 TEST RESULTS

In the functional test performed while the specimen temperature was stabilized at 5(+0, -4)°F, no leakage existed when the inlet and outlet ports were alternately pressurized to 50 psig.

7.4 TEST DATA

Test data are presented in table 7-1.

Table 7-1. Data Obtained During Low Temperature Test

Run	Applied Pressure (psig)	Response Time (ms)		Seat Leakage (scim)	
		Opening	Closing	Inlet Port	Outlet Port
1		482	515		
2		463	480		
3		452	508		
	50			0	0

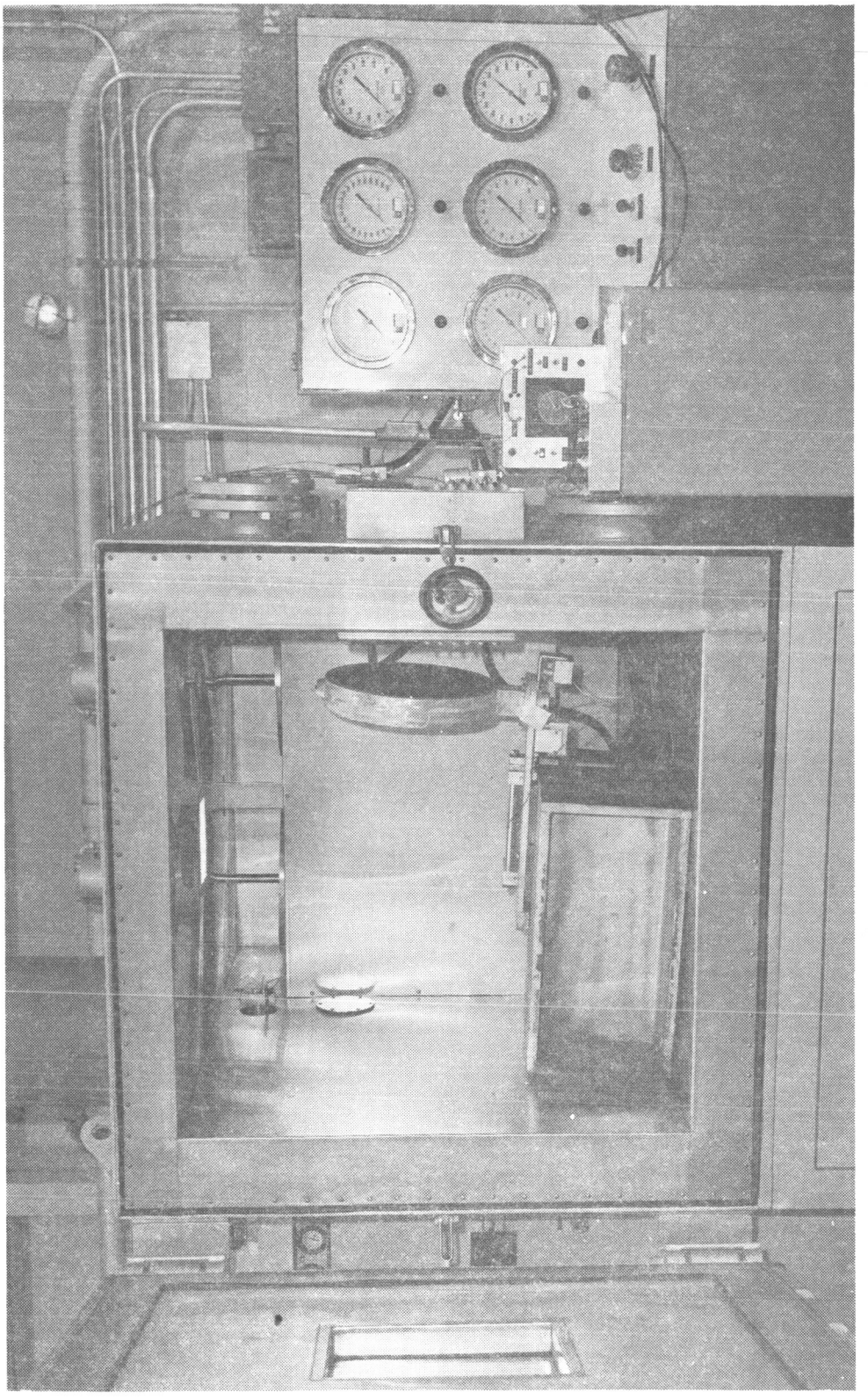


Figure 7-1. Low and High Temperature Test Setup

SECTION VIII

HIGH TEMPERATURE TEST

8.1 TEST REQUIREMENTS

8.1.1 A high temperature test will be performed on the test specimen to determine whether the environment causes degradation or deformation.

8.1.2 The rated high temperature is 160(+5, -0)°F.

8.1.3 A functional test shall be performed during this test.

8.2 TEST PROCEDURE

8.2.1 The test specimen was placed in a temperature chamber using the test setup shown in figure 4-1 (installation A or B as required), and figure 7-1 and the equipment listed in table 4-1.

8.2.2 The temperature of chamber 20 was increased to 160 (+5, -0)°F, maintaining a relative humidity of 20 ($\pm$5) per cent. The maximum temperature change rate did not exceed 1°F per minute.

8.2.3 This temperature was maintained for 72 hours.

8.2.4 A functional test was conducted at the end of 72 hours while the chamber temperature was maintained.

8.2.5 The chamber temperature was returned to ambient conditions upon completion of the functional test.

8.2.6 The specimen was visually inspected and functionally tested immediately following the establishment of ambient conditions.

8.2.7 The test data were recorded.

8.3 TEST RESULTS

In the functional test performed after the specimen temperature was stabilized for 72 hours at 160 (+5, -0)°F, no leakage existed when the inlet and outlet ports were alternately pressurized at 50 psig.

8.4 TEST DATA

Test data are presented in table 8-1.

Table 8-1. Data Obtained During High Temperature Test

Run	Applied Pressure (psig)	Response Time (ms)		Seat Leakage (scim)	
		Opening	Closing	Inlet Port	Outlet Port
1	-	400	491	-	-
2	-	397	498	-	-
3	-	405	510	-	-
	50			0	0

SECTION IX

CYCLE TEST

9.1 TEST REQUIREMENTS

9.1.1 The test specimen shall be subjected to 5000 operational cycles to determine whether the environment causes deformation or degradation of performance.

9.1.2 Each cycle shall consist of fully opening the valve from the fully closed position and then fully closing the valve.

9.1.3 A functional test, as specified in section IV, shall be performed following the completion of 100, 500, 1000 cycles and each 1000 cycles thereafter.

9.2 TEST PROCEDURE

9.2.1 The test setup was assembled as shown in figures 9-1 and 9-2 using the equipment listed in table 9-1.

9.2.2 A functional test was performed because more than 72 hours had elapsed since the previous functional test.

9.2.3 All hand valves were closed and pressure regulator 5 was adjusted for zero outlet pressure.

9.2.4 Hand valve 2 was opened.

9.2.5 The reading on pressure gage 4 was 3200 psig.

9.2.6 Regulator 5 was adjusted to establish 150 psig as indicated on pressure gage 6.

9.2.7 Hand valve 8 was opened.

9.2.8 Timer 13 was started. The timer began cycling solenoid valves 9 and 10.

9.2.9 The specimen was subjected to 5000 cycles as indicated by counter 12.

9.2.10 A functional test was performed after 100, 500, and 1000 cycles and each 1000 cycles thereafter.

9.2.11 The test data were recorded.

9.3 TEST RESULTS

The cycle test was interrupted after cycles 35, 1040, and 4824 due to binding of the piston shaft. The binding was caused by slippage of the key that holds the butterfly shaft in the wrench arm. In each instance, readjustment of the key restored the

valve to operational condition until slippage again occurred. The specimen performance, however, was satisfactory.

9.4 TEST DATA

9.4.1 Functional test data obtained during the cycle test are presented in table 9-2.

9.4.2 Figures 9-3 and 9-4 show shaft scoring and misalignment.

Table 9-1. Cycle Test Equipment List

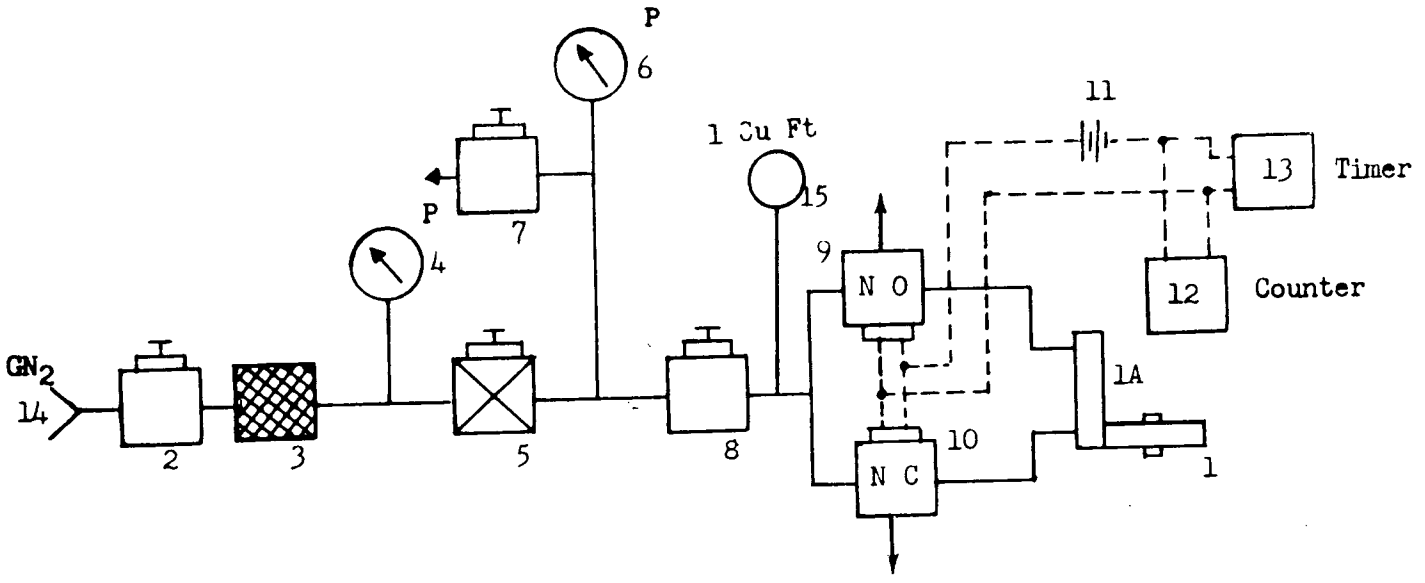
Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Keystone Valve Corp.	100	NA	Butterfly valve, 14-inch
1A	Specimen Actuator		6325	NA	Cylinder
2	Hand Valve	Combination Pump and Valve Co.	NA	NA	1-½-inch
3	Filter	Bendix	1730130	2-S-13460-16-8-0	2-micron
4	Pressure Gage	Duragauge	NA	NASA 200616-L	0-to 5000-psig ±2% FS accuracy Cal date 11-3-66
5	Regulator	Tescom	26-1003	1005	4000-psig inlet 0-to 2000-psig outlet
6	Pressure Gage	Ashcroft	NA	NASA 200616-Q	0-to 160 psig ±0.25% accuracy Cal date 10-27-66
7	Hand Valve	Robbins Aviation, Inc.	SSKG-250 4T	NA	¼-inch
8	Hand Valve		NA	NA	½-inch
9	Solenoid Valve	Marotta	MV-121	115	1-inch, 2-way normally open
10	Solenoid Valve	Marotta	MV-583	356	½-inch, 2-way normally closed
11	Power Supply	CCSD	NA	NA	28-vdc
12	Counter	Durant		NA	4-digit
13	Timer	Cramer	623	Y-3336-A	Cam-operated
14	GN_2 Source	CCSD	NA	NA	3000-psig
15	Sphere	CCSD	NA	NA	1-cubic-foot fiberglass

Table 9-2. Cycle Test Data

Prerun Cycles (Cy)	Run	Applied Pressure (psig)	Response Time (ms)		Seat Leakage (scim)	
			Opening	Closing	Inlet Port	Outlet Port
100	1	-	355	455	-	-
	2	-	354	417	-	-
	3	-	360	402	-	-
		50			0	0
500	1	-	347	462	-	-
	2	-	319	444	-	-
	3	-	375	419	-	-
		50			0	0
1000	1	-	385	435	-	-
	2	-	375	420	-	-
	3	-	335	415	-	-
		50			0	0
2000	1	-	318	358	-	-
	2	-	334	362	-	-
	3	-	338	363	-	-
		50			0	0
3000	1	-	366	349	-	-
	2	-	354	360	-	-
	3	-	345	345	-	-
		50			0	0

Table 9-2. Cycle Test Data (Contd.)

Prerun Cycles (Cy)	Run	Applied Pressure (psig)	Response Time (ms)		Seat Leakage (scim)	
			Opening	Closing	Inlet Port	Outlet Port
4000	1	-	318	358	-	-
	2	-	334	362	-	-
	3	-	338	363	-	-
		50			0	0
5000	1	-	366	349	-	-
	2	-	354	360	-	-
	3	-	345	345	-	-
		50			0	0



Note: All lines 1/2 inch.
Refer to table 9-1 for item identification.

Figure 9-1. Cycle Test Schematic

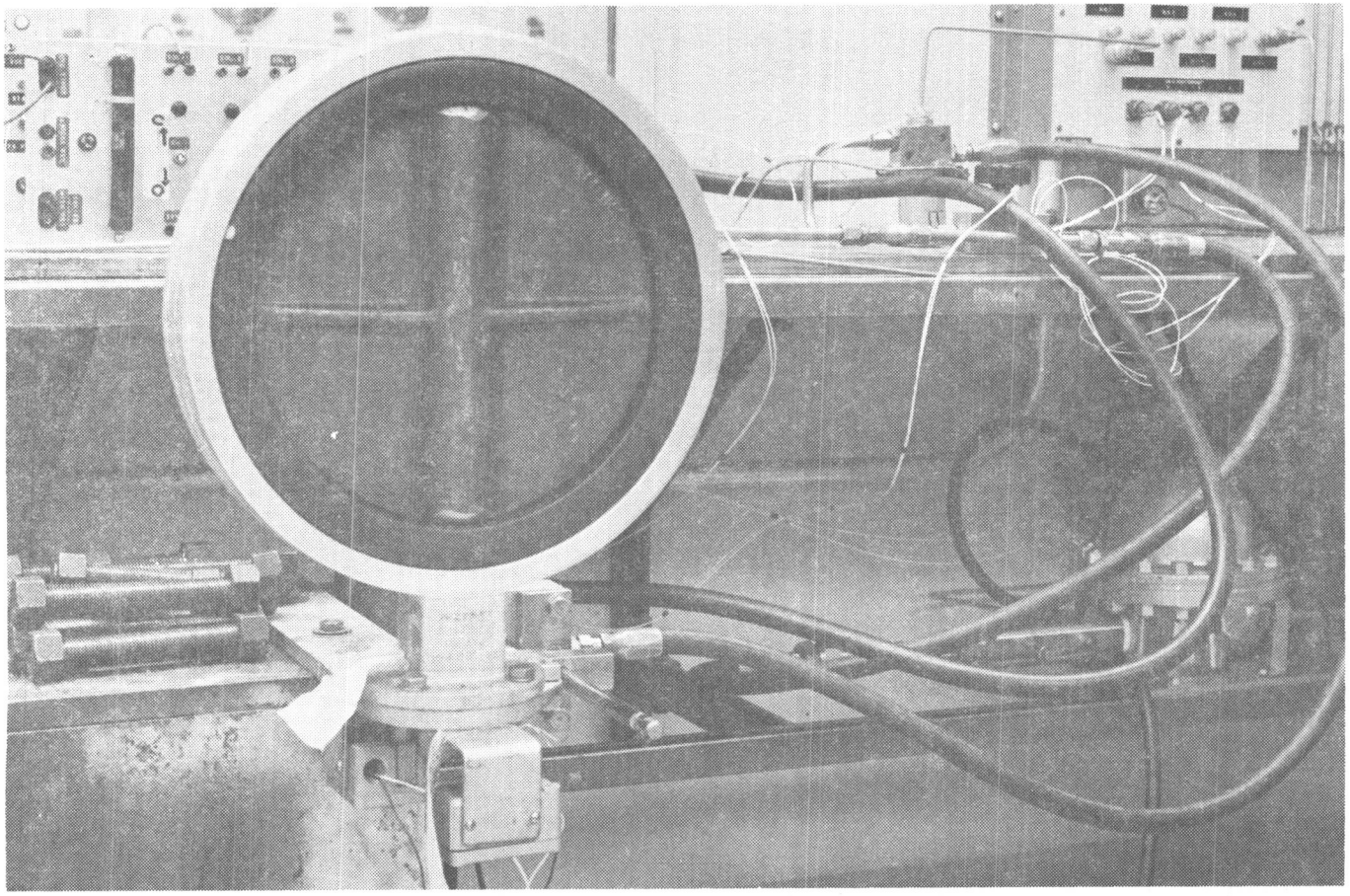


Figure 9-2. Cycle Test Setup

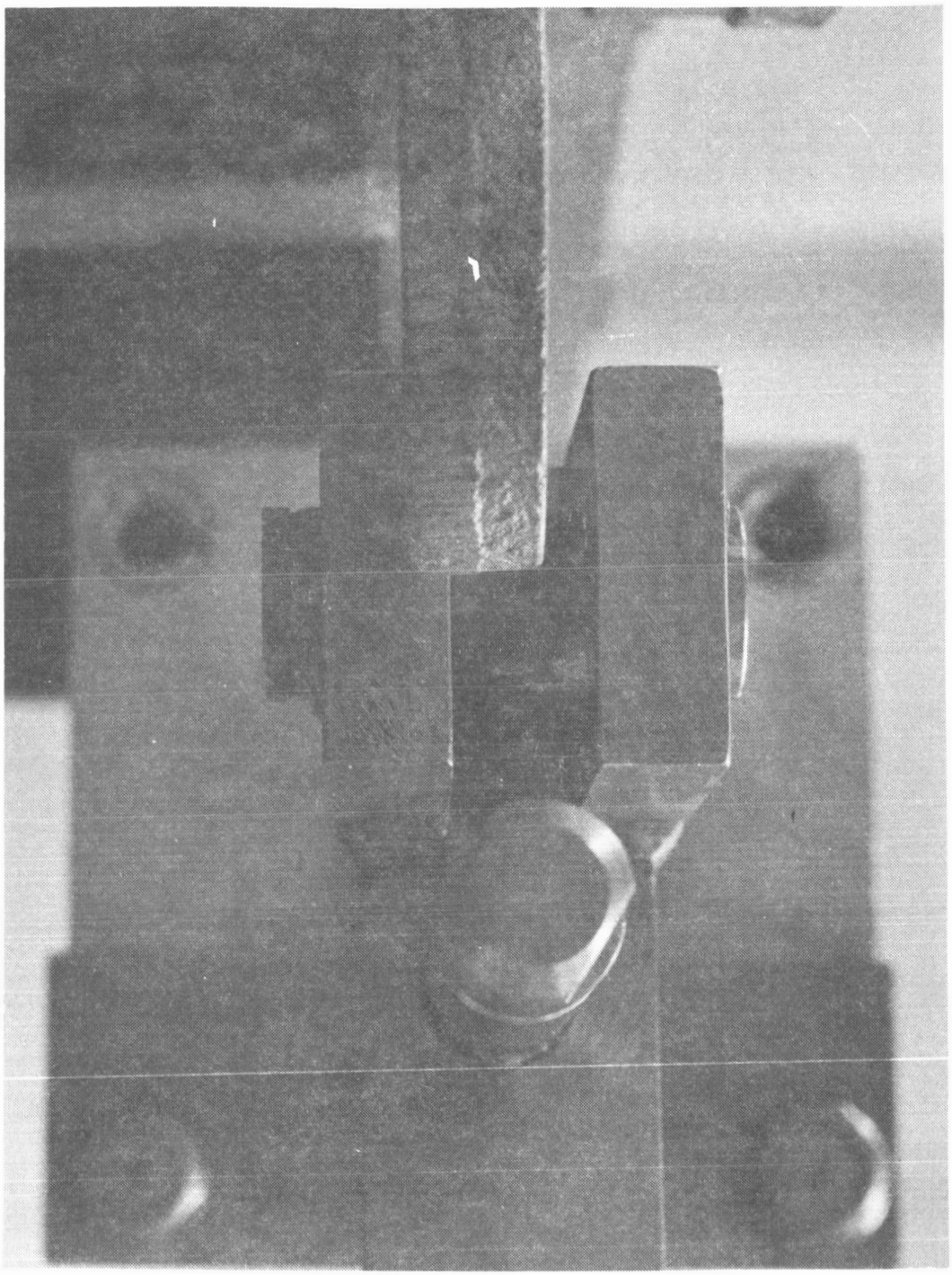


Figure 9-3. Misalignment After Hub Slippage

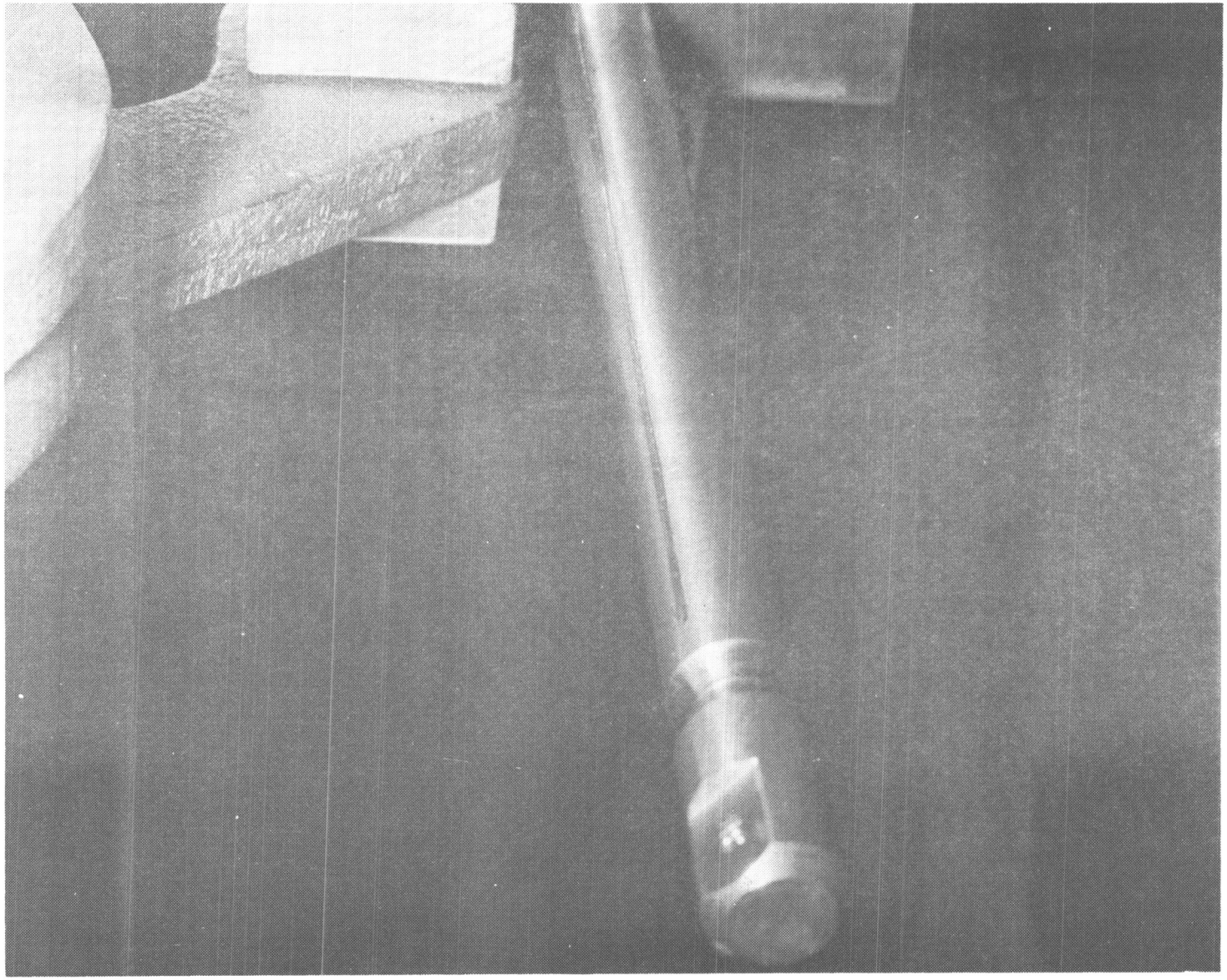


Figure 7-4. Scoring of Guide Shaft

SECTION X

BURST TEST

10.1 TEST REQUIREMENTS

10.1.1 The specimen body shall be subjected to a hydrostatic pressure of 600 psig to determine the structural integrity of the specimen.

10.1.2 The hydrostatic pressure shall be applied simultaneously to specimen inlet and outlet ports and shall be maintained for 5 minutes.

10.1.3 The specimen actuator shall be then subjected to a hydrostatic pressure of 600 psig. This pressure shall be applied simultaneously to both actuator ports and shall be maintained for 5 minutes.

10.1.4 The specimen shall be inspected for leakage and distortion.

10.2 TEST PROCEDURE

10.2.1 The test setup was assembled as shown in figure 10-1 (installation A) and figure 10-2 using the equipment listed in table 10-1.

10.2.2 All valves were closed and regulator 21 was adjusted to zero outlet pressure.

10.2.3 Hand valves 6, 7, 8, 9, 10, and 11 were opened to fill the system with water. The fittings at gage 3 and at the specimen were loosened as required to bleed trapped air.

10.2.4 Hand valves 6, 8, 9, and 11 were closed.

10.2.5 Hand valve 5 was opened. The pressure on gage 14 was 3200 psig.

10.2.6 Regulator 21 was adjusted to provide a pressure of 50 to 100 psig as indicated on gage 15.

10.2.7 Switch 17 was closed to open solenoid valve 18. Pump 19 began operating.

10.2.8 Pumping was continued until specimen body pressure, as indicated by gage 3, was 600 psig. Switch 17 was opened to stop pump 19.

10.2.9 The 600-psig pressure was maintained for 5 minutes. The specimen was checked for leakage and distortion.

10.2.10 Hand valves 8 and 11 were opened to vent pressure from the specimen and gage.

10.2.11 All test data were recorded.

10.2.12 The test setup was assembled as shown in figure 10-1 (installation B) using the equipment listed in table 10-1.

10.2.13 Procedures described in 10.2.2 through 10.2.11 were repeated.

10.3 TEST RESULTS

10.3.1 No leakage occurred when the inlet and outlet ports of the specimen were simultaneously pressurized to 600 psig.

10.3.2 Extensive leakage occurred when both actuator ports of the specimen were pressurized to 600 psig.

10.3.3 No damage or distortion resulted from the burst pressure test.

10.4 TEST DATA

The data recorded during the burst pressure test are recorded in table 10-2.

Table 10-1. Burst Test Equipment List

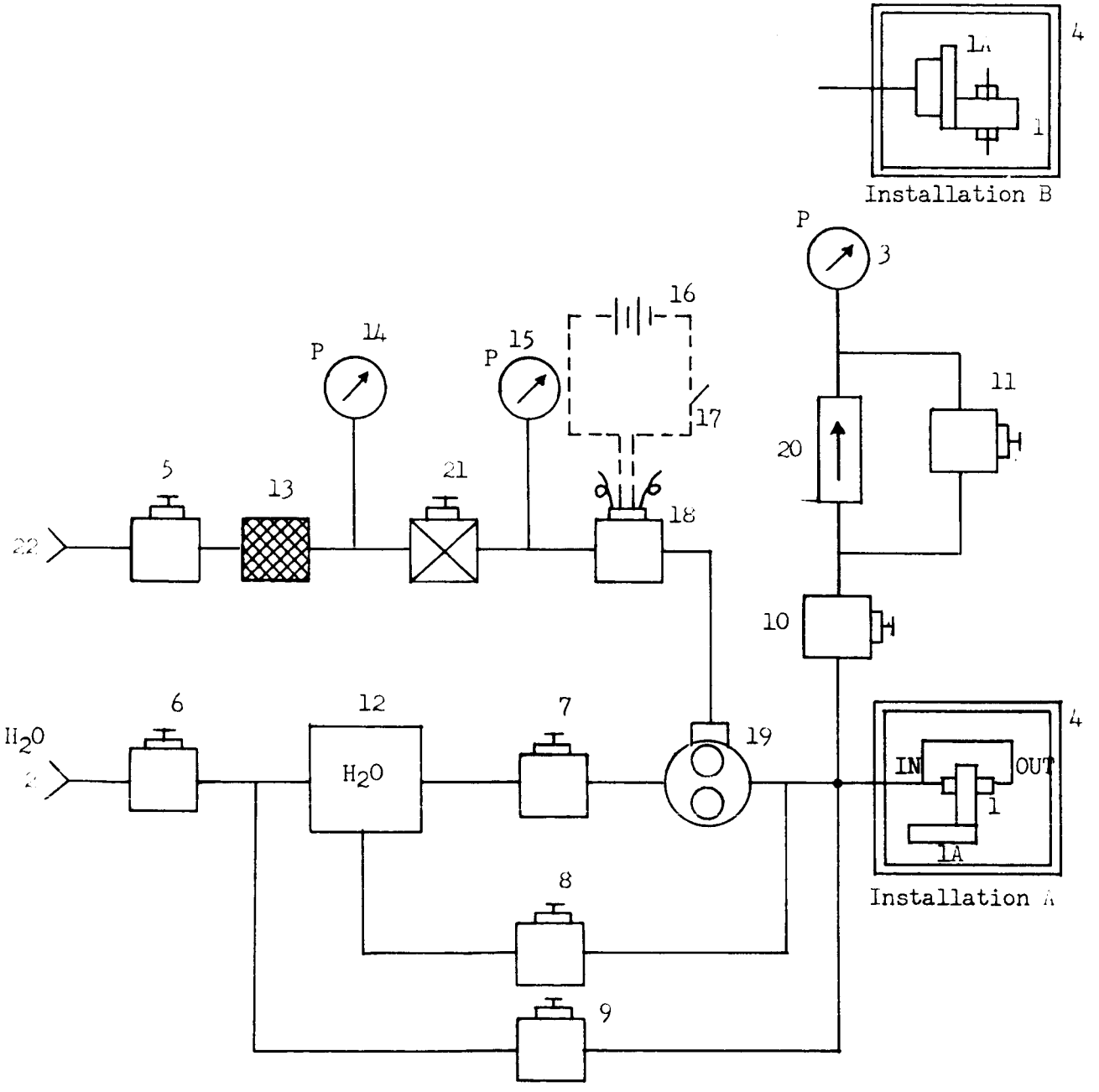
Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Keystone Valve Corp.	100	NA	Butterfly valve, 14-inch
1A	Specimen Actuator		6325	NA	Cylinder
2	Water Supply		NA	NA	Tap water
3	Hydrostatic Pressure Gage	Astra	NA	NASA 011893-A	0-to 100,000-psig ±0.5% FS accuracy Cal date 11-2-60
4	Burst Chamber	CCSD	NA	NASA 201344	3-by 3-by 3-foot
5	Hand Valve	Aminco	50011A	NA	¼-inch
6	Hand Valve	Aminco	50011A	NA	¼-inch
7	Hand Valve	Aminco	50011A	NA	¼-inch
8	Hand Valve	Aminco	50011A	NA	¼-inch
9	Hand Valve	Aminco	50011A	NA	¼-inch
10	Hand Valve	Aminco	50011A	NA	¼-inch
11	Hand Valve	Aminco	50011A	NA	¼-inch
12	Water Reservoir	CCSD	NA	NA	2-gallon
13	Pneumatic Filter	The Bendix	1731260	NA	2-micron
14	Pneumatic Gage	Ashcroft	10575	NA	0-to 5000-psig +2% FS accuracy Uncalibrated reference
15	Pneumatic Gage	USG	8990	NA	0-to 300-psig +2% FS accuracy Uncalibrated reference

Table 10-1. Burst Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
16	Power Supply	CCSD	NA	NA	28-vdc
17	Switch	Cutler Hammer Co.	NA	NA	SPST
18	Solenoid Valve	Marotta	207803	NA	2-way normally closed
19	Hydrostatic Pump	Sprague Engineering Corp.	NA	300-16-64	Air-operated, maximum pressure 50,000 psig
20	Check Valve	Aminco	44-6305	NA	¼-inch
21	Regulator	Marotta	NA	NA	3000-psig inlet 0-to 200-psig outlet
22	Pneumatic Pressure Source	Air Products	NA	NA	3000-psig

Table 10-2. Burst Test Data

Pressure (psig)	Time (min.)	Results
600	5	No damage or distortion observed



Note: All lines 1/4 inch.
See table 10-1 for item identification.

Figure 10-1. Burst Test Schematic

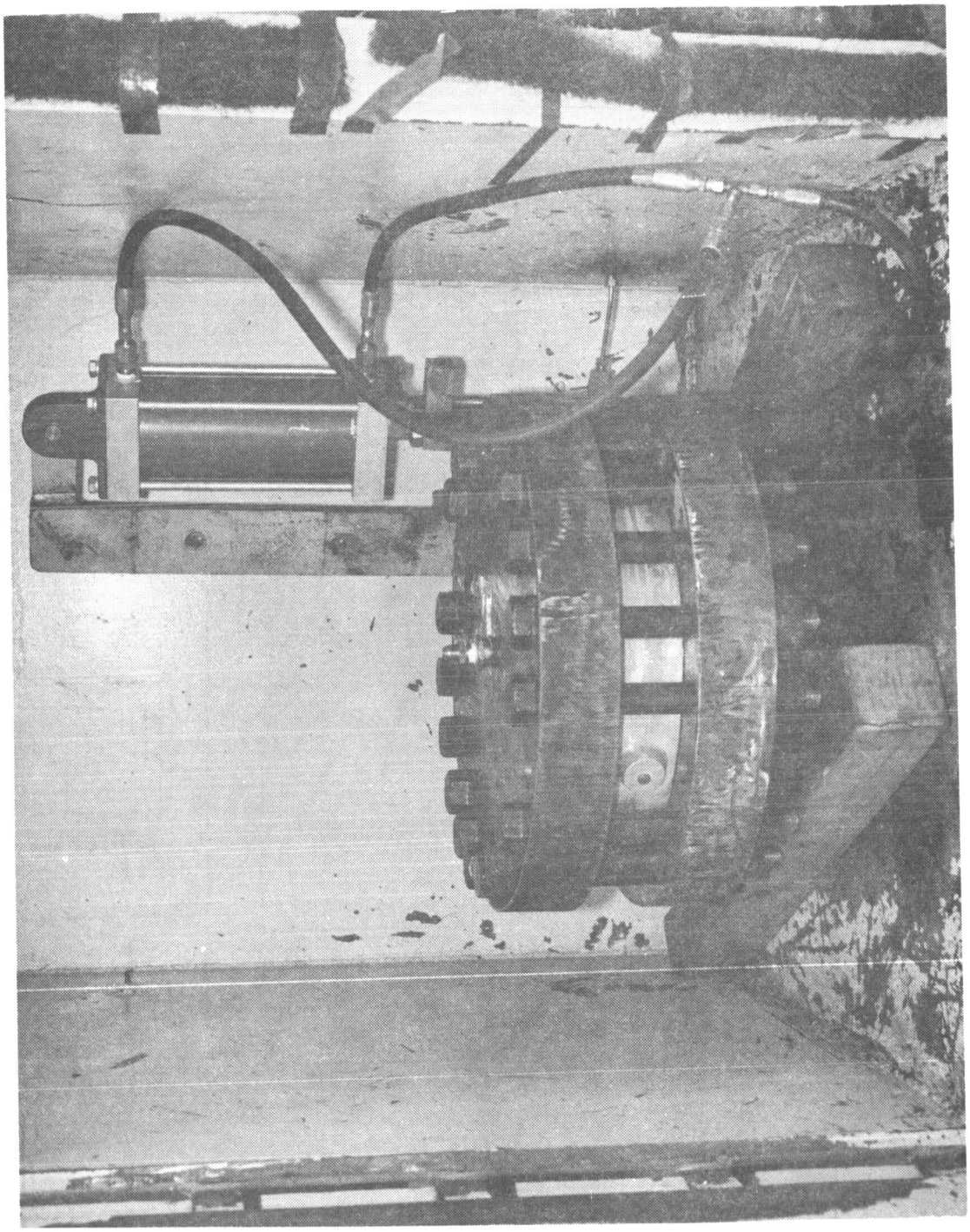


Figure 10-2. Burst Test Setup

APPROVAL

TEST REPORT

FOR

BUTTERFLY VALVE, 14-INCH, PNEUMATICALLY OPERATED

Keystone Valve Corporation Series 100, Cylinder 952-2-700-009

NASA Drawing Number 75M04406 PBFV-7

SUBMITTED BY:

G. Collins
Test and Evaluation Section

APPROVALS

R. W. Claunch
Program Supervisor

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